NORTH ATLANTIC TREATY ORGANIZATION

SCIENCE AND TECHNOLOGY ORGANIZATION

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STO TECHNICAL REPORT **TR-MSG-098**

Urban Combat Advanced Training Technology Architecture

(Architecture de technologie avancée pour l'entraînement au combat urbain)

Final Report of Task Group MSG-098 UCATT Architecture.

Published January 2018

Distribution and Availability on Back Cover

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The NATO Science and Technology Organization

Science & Technology (S&T) in the NATO context is defined as the selective and rigorous generation and application of state-of-the-art, validated knowledge for defence and security purposes. S&T activities embrace scientific research, technology development, transition, application and field-testing, experimentation and a range of related scientific activities that include systems engineering, operational research and analysis, synthesis, integration and validation of knowledge derived through the scientific method.

In NATO, S&T is addressed using different business models, namely a collaborative business model where NATO provides a forum where NATO Nations and partner Nations elect to use their national resources to define, conduct and promote cooperative research and information exchange, and secondly an in-house delivery business model where S&T activities are conducted in a NATO dedicated executive body, having its own personnel, capabilities and infrastructure.

The mission of the NATO Science & Technology Organization (STO) is to help position the Nations' and NATO's S&T investments as a strategic enabler of the knowledge and technology advantage for the defence and security posture of NATO Nations and partner Nations, by conducting and promoting S&T activities that augment and leverage the capabilities and programmes of the Alliance, of the NATO Nations and the partner Nations, in support of NATO's objectives, and contributing to NATO's ability to enable and influence security and defence related capability development and threat mitigation in NATO Nations and partner Nations, in accordance with NATO policies.

The total spectrum of this collaborative effort is addressed by six Technical Panels who manage a wide range of scientific research activities, a Group specialising in modelling and simulation, plus a Committee dedicated to supporting the information management needs of the organization.

- AVT Applied Vehicle Technology Panel
- HFM Human Factors and Medicine Panel
- IST Information Systems Technology Panel
- NMSG NATO Modelling and Simulation Group
- SAS System Analysis and Studies Panel
- SCI Systems Concepts and Integration Panel
- SET Sensors and Electronics Technology Panel

These Panels and Group are the power-house of the collaborative model and are made up of national representatives as well as recognised world-class scientists, engineers and information specialists. In addition to providing critical technical oversight, they also provide a communication link to military users and other NATO bodies.

The scientific and technological work is carried out by Technical Teams, created under one or more of these eight bodies, for specific research activities which have a defined duration. These research activities can take a variety of forms, including Task Groups, Workshops, Symposia, Specialists' Meetings, Lecture Series and Technical Courses.

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List of Acronyms

AAR	After Action Review
ADSA	AWES Distributed Situational Awareness
AG	Architecture Task Group
AGDUS	Ausbildungsgerät Duellsimulator/ Tactical Engagement Simulator in German Language
AIME	Architecture Independent Modelling Environment
AWES	Area Weapon Effects System
BATUS	British Army Training Unit Suffield
BG	Battle Group
BMS	Battlefield Management System
C4I	Command, Control, Communications, Computers and Intelligence
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
C-BML[1]	Coalition Battle Management Language
CBRN	Chemical, Biological, Radiological, Nuclear
CRM	Capability Requirement Matrix
CTC	Combat Training Centre
CTE	Collective Training Establishment
DA	Design Architecture
DFWES	Direct Fire Weapon Effects System
DIS[2]	Distributed Interactive Simulation
DO	Dynamic Object
EMP	Electro Magnetic Pulse
EU	European Union
EXCON	Exercise Control
FA	Functional Architecture
FIBUA	Fighting In Built-Up Areas
GefübZH	GefechtsübungsZentrum Heer
GPS	Global Positioning System
HICON	Higher Control
HLA[3]	High Level Architecture
HQ	Headquarters
ID	Identification
IED	Improvised Explosive Device
IEEE	Institute of Electrical and Electronics Engineers
IFF	Identification Friend or Foe

1 Coalition-Battle Management Language (C-BML) is a SISO standard (SISO-STD-008-200X) for defining military orders.

2 Distributed Interactive Simulation (DIS) is an IEEE standard (1278) for conducting real-time platform-level simulation. Improvements in DIS are promulgated by SISO.

3 The High Level Architecture (HLA) is an IEEE standard (1516) and a STANAG (4603). It is a general purpose architecture for distributed computer simulation systems. SISO created a standardised process for developing interoperable HLA based federations called Distributed Simulation Engineering and Execution Process (IEEE 1730).

IR	Infrared
IRF	Immediate Response Force
ISTAR	Intelligence, Surveillance, Target Acquisition and Reconnaissance
IUC	International User Community
JC3IEDM[4]	Joint Consultation, Command and Control Information Exchange Data Model
JMRC	Joint Military Readiness Centre
JMTC	Joint Military Training Centre
LCC	Land Component Command
LO2020	Land Operations in the Year 2020
LSS	Live Simulation Standards
LVC	Live, Virtual, Constructive
M&S	Modelling and Simulation
MCTC	Mobile Combat Training Centre
MILES	Multiple Integrated Laser Engagement System
MIP	Multinational Interoperability Programme
MOD	Ministry Of Defence
MOU	Memorandum Of Understanding
MOUT	Military Operations in Urban Terrain
MSDL[5]	Military Scenario Definition Language
MSG	Modelling and Simulation Group
MSMP	Modelling and Simulation Master Plan
MST	Mission Specific Training
NAAG	NATO Army Armaments Group
NACMTC	Norwegian Army Combat Manoeuvre Training Centre
NAF	NATO Architectural Framework
NATO	North Atlantic Treaty Organization
NC	Network Controller
NLOS	Non Line of Sight
NLW	Non-Lethal (or less than lethal) Weapon
NMSG	NATO Modelling and Simulation Group
NRF	NATO Response Force
O/C	Observer Controller
OPFOR	Opposing Forces
ORBAT	Order of Battle
OSAG	Optical interface specification for the German CTC
OSI	Open System Interconnection
PD15	PASHTUN DAWN 15 (military exercise)
PDG	Product Development Group
PfP	Partnership for Peace
PSG	Product Support Group
RC-IED	Radio Controlled Improvised Explosive Device
RF	Radio Frequency
RNLA	Royal Netherlands Army

[4] The Joint Consultation, Command and Control Information Exchange Data Model (JC3IEDM) is managed by the Multilateral Interoperability Programme (MIP), a consortium of NATO and Non-NATO nations that define interoperability specifications for the exchange information between their national Command and Control systems.

[5] Military Scenario Definition Language (MSDL) is a SISO standard (SISO-STD-007-2008) for defining military scenarios.

SG	Standards Task Group
SISO	Simulation Interoperability Standards Organization
STO	Science and Technology Organization
STOG	Simulation Training and Operations Group
TAP	Technical Activity Proposal
TBD	To Be Defined / To Be Determined
TENA	Test and training Enabling Architecture
TES	Tactical Engagement Simulation
TG	Task Group
TOE	Team Of Experts
TOR	Terms Of Reference
TSWG	Training and Simulation Working Group
TTESIK	Temporary Tactical Engagement Simulation In Kenya
UAV	Unmanned Aerial Vehicle
UCATT	Urban Combat Advanced Training Technology
UO2020	Urban Operations in the Year 2020
UOWG	Urban Operations Working Group
USRI	Urban Short Range Interaction

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The Chairman wishes to thank all those members of the Task Group (TG) from both Government and Industry from each of the participating nations for their hard work and endeavours in delivering this report and also for their contributions, challenge and scrutiny during the life and work of the UCATT Architecture TG.

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- Mr. Mathew Wright (GBR)
- Maj Roger Karlsson (SWE)
- Mr. Anders Holmquist (SWE)
- Mr. Leif Nyfeldt (SWE)
- Mr. Thomas Desfachelles (FRA)
- Lt Col Rolf Lerch (CHE)
- Mr. Stéphane Forgues (CAN)

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The Chairman and the Task Group as a whole particular extend their thanks to Mr. Rudi Gouweleeuw (NLD). Rudi has facilitated our discussions, brought challenge to the debate and applied logical process to our work. He has been tireless in supporting the group and without his contribution the work of the group would have been less effective.

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Urban Combat Advanced Training Technology Architecture

(STO-TR-MSG-098)

Executive Summary

The focus of the MSG-098 "Urban Combat Advanced Training Technology (UCATT) Architecture" Task Group (TG) was on the maintenance and improvement of the previously developed functional architecture and the identification and prioritisation of a standard set of interfaces that enable interoperability of live training components without inhibiting future research and enhancements.

Perhaps uniquely within NMSG the UCATT Architecture TG from the outset drew its members from active duty military, government and industry. UCATT has developed to become a focal point of knowledge and information exchange on live simulation within NATO and PfP. The continuation of the UCATT activities within MSG-140 "UCATT Live Simulation Standards (LSS)" secures not only a vehicle for continued work on standardisation, but also one to embed and support the goals already achieved.

MSG-098 established very close liaison with MSG-099 UCATT Standards TG. MSG-098 and MSG-099 together form the UCATT Task Group whose members represent the majority of the SISO UCATT PDG. In conclusion the work of the UCATT TG to date has provided NATO with a usable SISO standard for a laser engagement interface. Datasets for other interfaces to be standardised have been identified and described in detail. The applicability of JC3IEDM, MSDL and C-BML as potential standard candidates for C4I-integration has been evaluated.

The recommendations of the UCATT Architecture TG's work are outlined below:

1) Involve new countries and industries and re-engage with countries that have ceased earlier active involvement in the group.
2) Increase the "marketing" activities to create more awareness of the UCATT standard for live simulation systems within the User community.
3) Reactivate the relationship between UCATT TG and the Simulation Training and Operations Group.
4) Establish liaison between the UCATT community and the NATO and SISO efforts enhancing the JC3IEDM, C-BML and MSDL standards.
5) Merge the standardisation and architectural activities together into the follow-up Task Group.
6) Continuation of the SISO membership funding for government members of MSG-140.
7) Consider the translation of the currently used functional architecture into the NATO Architectural Framework (NAF) if applicable and useful.

These recommendations have been recognised by STO and that the work of UCATT should continue for four main reasons:

- To continue the standardisation effort;
- To form the basis of SISO PSGs necessary for the maintenance and availability of interface standards;

- To acknowledge the applicability of the UCATT work is beyond just Urban training systems and applies to live simulation systems and Combat Training Centres in general; and
- To accommodate the increased international interest in the interoperability opportunities UCATT can provide and invite other nations and participants.

Architecture de technologie avancée pour l'entraînement au combat urbain

(STO-TR-MSG-098)

Synthèse

Le groupe de travail (TG) MSG-098 « Architecture de technologie avancée pour l'entraînement au combat urbain (UCATT) » s'est focalisé sur le maintien et l'amélioration de l'architecture fonctionnelle précédemment développée et sur l'identification et la hiérarchisation d'un ensemble standard d'interfaces qui permettent l'interopérabilité des composants d'entraînement en conditions réelles sans freiner les recherches et améliorations futures.

Dès le départ, le TG MSG-098 a recruté ses membres au sein du personnel militaire en service actif, des gouvernements et de l'industrie, ce qui est peut-être unique au sein du NMSG. L'UCATT s'est développée au point de devenir le carrefour des connaissances et de l'échange d'informations sur la simulation en conditions réelles au sein de l'OTAN et du PpP. La poursuite des activités UCATT au sein du MSG-140 « Normes de simulation en conditions réelles (LSS) » est non seulement l'assurance de la continuité des travaux de normalisation, mais également le moyen d'intégrer et soutenir les buts déjà atteints.

Le MSG-098 a établi une liaison très étroite avec le TG MSG-099 « Normes UCATT ». Le MSG-098 et le MSG-099 forment ensemble le groupe de travail UCATT, dont les membres représentent la majorité du groupe de développement de produit (PDG) UCATT SISO. En conclusion, le travail du TG UCATT a fourni jusqu'à présent à l'OTAN une norme SISO utilisable pour une interface d'engagement laser. Les ensembles de données destinés aux autres interfaces à normaliser ont été identifiés et décrits en détail. L'applicabilité des normes JC3IEDM, MSDL et C-BML pour l'intégration C4I a été évaluée.

Les recommandations du TG sur l'architecture UCATT sont indiquées ci-dessous :

1) Impliquer de nouveaux pays et secteurs économiques et réimpliquer les pays qui ont cessé leur implication active dans le groupe.
2) Augmenter les activités de « marketing » pour faire connaître la norme UCATT destinée aux systèmes de simulation en conditions réelles au sein de la communauté des utilisateurs.
3) Réactiver les relations entre le TG UCATT et le Groupe de simulation pour l'entraînement et les opérations.
4) Etablir une liaison entre la communauté UCATT et l'OTAN d'une part, et les travaux de la SISO améliorant les normes JC3IEDM, C-BML et MSDL d'autre part.
5) Fusionner les activités de normalisation et d'architecture au sein du groupe de travail de suivi.
6) Poursuivre le financement de l'adhésion à la SISO des membres gouvernementaux du MSG-140.
7) Envisager la traduction de l'architecture fonctionnelle actuellement utilisée au sein du cadre d'architecture de l'OTAN (NAF) s'il y a lieu.

La STO a pris note de ces recommandations et le travail de l'UCATT devrait se poursuivre dans quatre directions principales :

- Continuer les travaux de normalisation ;

- Former la base de groupes d'assistance technique des produits (PSG) de la SISO, veillant à la maintenance et la disponibilité des normes d'interface ;
- Reconnaître que les travaux UCATT dépassent le champ des systèmes d'entraînement urbain et s'appliquent aux systèmes de simulation en conditions réelles et aux centres d'entraînement au combat en général ; et
- Tenir compte de l'intérêt international accru porté aux opportunités d'interopérabilité que l'UCATT peut offrir et inviter d'autres pays et participants.

Chapter 1 − OVERVIEW

1.1 INTRODUCTION

Ground based warfare in an urban context is perhaps the most deadly and complex type that tends to neutralise much of the technical superiority of modern armies. As such preparedness for operations in such an environment is vital for success. Investments in the first generation of modern combat training centres (with instrumentation for data collection and analysis) with urban training facilities began in the 1990s. These capabilities are generally bespoke simulation designs to national requirements not lending themselves easily to support training events for contemporary coalition style operations as they have limited ability to achieve standardisation and interoperability. The NATO structure and objectives make NATO a suitable organisation to seek to harmonise training requirements and move toward common technical architecture and standards for the next generation facilities. The NATO Modelling and Simulation action / Master Plan (MSMP) cites the need for common open standards and technical frameworks to promote the interoperability and reuse of models and simulations across the Alliance. Included in this is the need for a common technical framework to support Live instrumented training among members of the Alliance.

1.2 BACKGROUND

Two NATO studies are the genesis of the UCATT work:

1) The NATO Research and Technology Organisation (RTO) 1999 Technical Report, Land Operations in the Year 2020 (LO2020); and

2) The 2003 Urban Operations in the Year 2020 (UO2020) report. LO2020, in particular (as have other studies) concluded that NATO forces would likely have to conduct future operations in urban areas.

In response and in support of the MSMP, a Team of Experts from NATO NAAG completed in 2002 a feasibility study and concluded that a number of potential interoperability areas were worthy of further investigation. As a result the Urban Combat Advanced Training Technology (UCATT) Task Group (TG) was established within the NATO Modelling and Simulation Group (NMSG). Perhaps uniquely from the outset UCATT drew members from both government and industry bodies. UCATT has become the NATO focal point for Urban training technology and data exchange requirements for live training in the land domain. It is well regarded among the military community and industry as the driving force within the live domain.

1.2.1 UCATT-1

In 2003 as MSG-032/TG-023, UCATT (later known as UCATT-1) was tasked to exchange and assess information on Urban facilities and training/simulation systems with a view toward establishing (then) best practice and consider the issues of interoperability, architecture and interfaces to promote and enable interoperability. A Technical Report was delivered (RTO-TR-MSG-032) and a website (http://www.fibuamoutsite.info[1]) created which was maintained by the NATO Urban Operations TG. The UCATT-1 report became more or less the guideline for urban combat training facilities design.

1.2.2 UCATT-2

In 2007 as MSG-063/TG-040, UCATT-2 was tasked to continue the work of UCATT and also to undertake an international interoperability demonstration to show the potential benefit of interoperability standards and commence a process of defining standards data exchange and communication and audio and visual effects.

[1] This website is now closed and about to be re-launched under a new URL by the NATO Urban Operations TG.

In addition to delivering a Technical Report (STO-TR-MSG-063), a successful technical demonstration was held at the Marnehuizen training facility in the Netherlands in 2011 during which a proof-of-concept was presented showing how systems from multiple manufacturers might be integrated into a single training event.

1.2.3 UCATT-3

The availability and subsequent use of a set of standards would generate benefit if adopted. For the military community these include having interoperability across nations and suppliers to enable multinational exercises with a nations own equipment or choice of location leading to better training. For the acquisition community, it opens up the market and provides tools to aide specification and reduce integration costs. For industry, it offers the potential for a more open and potentially more frequent sales opportunity.

Therefore following the work of MSG-063, in 2011 two UCATT TGs were constituted to undertake the next phase of work: MSG-098 UCATT Architecture Task Group (referred to as the AG) and MSG-099 Standards Task Group (referred to as the SG). During this third period of UCATT, both Task Groups have operated in close concert with joint meetings to aid communication and understanding. This report is that of MSG-098, the Architecture Task Group. It documents the task to review and update the generic functional architecture developed under UCATT-2. Scenarios were developed to derive data exchange requirements for interfaces. Selected data exchange requirements were issued to the Standards Task Group (MSG-099) for development into standards.

The first truly tangible output (the UCATT Standard Interface for Laser Engagement, to be published by the Simulation Interoperability Standards Organization (SISO)) is in development as a joint MSG-098/MSG-099 activity. A UCATT Product Development Group (PDG) was chartered by SISO in November 2013 and is lead from MSG-098.

The UCATT-3 TGs MSG-098 and MSG-099 are succeeded by MSG-140, UCATT Live Simulation Standards (LSS). The different groups which have been part of the UCATT activity throughout the years are depicted in Figure 1-1.

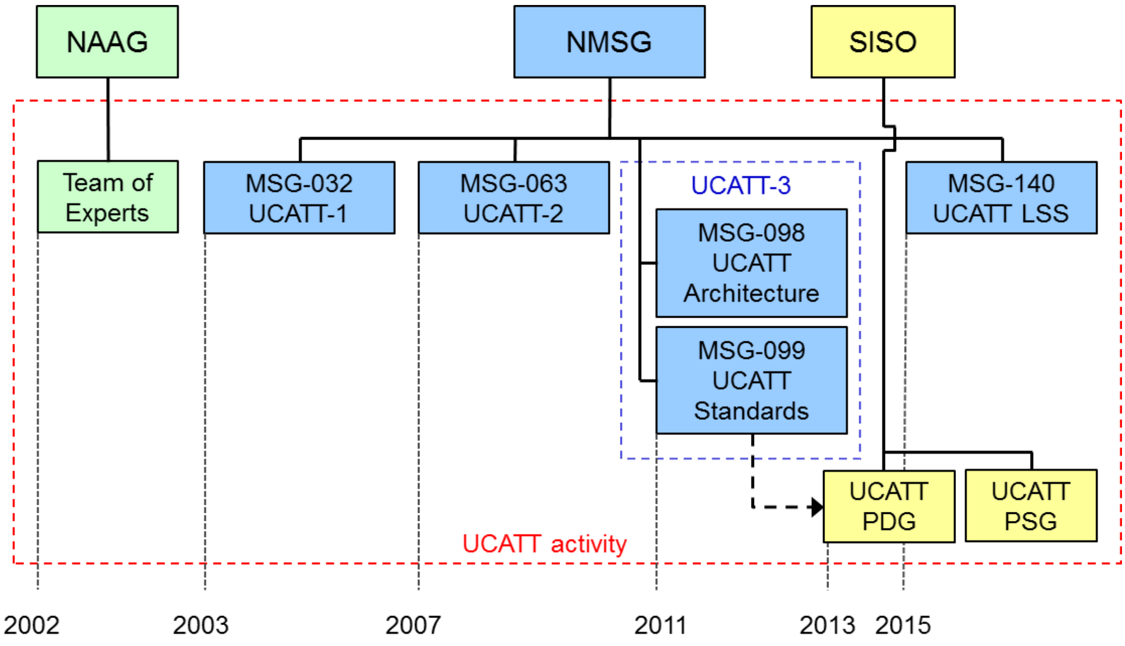

Figure 1-1: Composition of the UCATT Activity.

1.3 ILLUSTRATION OF THE NEED FOR UCATT BY CONTEMPORARY EXAMPLE SITUATIONS

One of the tasks performed by the AG was the validation of the Use Cases as the UCATT-1 TG formulated them. Those Use Cases have formed the basis of UCATT standardisation efforts ever since, but need validation periodically. It was considered best to validate them by comparing them to current multinational exercising needs and system interconnection efforts. The conclusion of the AG was, and is, that the Use Cases formulated are still valid. In the sections below, that conclusion is justified by describing a few recent or current-day example situations that depict the need for interoperability standards for live simulation systems.

1.3.1 RNLA: Connection of NLD Mobile Combat Training Centre to DEU CTC GefübZH Altmark

For many years the Royal Netherlands Army has conducted exercises in Germany, either alone or in conjunction with German forces. There is a contract in place for the use of the German CTC, GefechtsübungsZentrum Heer (GefübZH) Altmark, which arranges the use of the instrumented training area by Dutch forces at least twice a year.

For most interfaces however, both CTCs are not interoperable. Considerable efforts and investments have been made in the past to reach some form of workable interoperability. Full interoperability, for all interfaces, has not been achieved.

Apart from the optical laser interface for DFWES, using the OSAG-2 Basic laser coding (which is a downgrade for MCTC), the MCTC-GefübZH connection does not make use of standards. Interoperability is achieved by middleware, which acts as a translator between EXCONs. Because of that, MCTC still needs to be deployed fully, including the portable base stations, for players to interact with EXCON and vice versa. That means in that case the German CTC has a double set of base stations, one set each for every nation. This is a very inefficient solution, which can be solved by the use of standards on a component level, instead of a translator on a system level (see Figure 1-2).

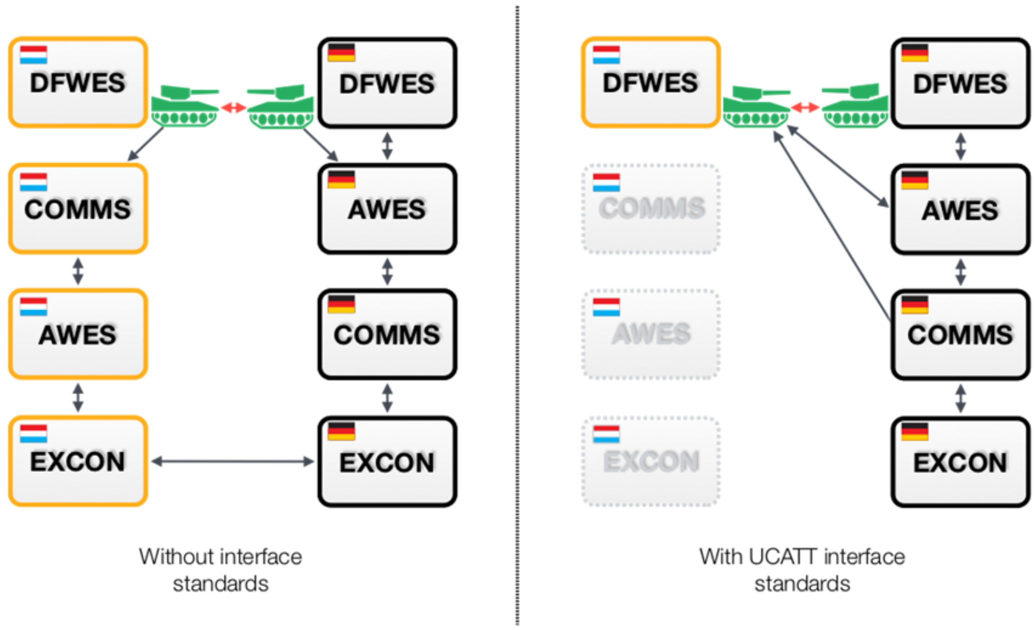

Figure 1-2: Interoperability Without and With UCATT Interface Standards.

The current solution is highly undesirable from a logistical and efficiency point of view even though it works. It should be noted that it is based purely on a stove-pipe connection which does not work in any other situation, using any other system. The use of the UCATT standard would allow the RNLA to deploy only its MCTC warehouse(s) and make use of the GefübZH Altmark EXCON and AAR facilities. At the same time, the MCTC EXCON and AAR facilities can then be used elsewhere to support an exercise parallel to the one in GefübZH Altmark.

1.3.2 RNLA: Integration of Forces on a Tactical Level Within NATO and EU

The current economic climate has forced most (if not all) European and NATO forces to work together more closely to address gaps in both capabilities and quantity of troops. Even though cooperation between armed forces is not new, the intensity and the level on which it occurs is changing. Also outside combined forces initiatives like the NATO Response Force (NRF) and the EU Battle Group, MOUs (Memorandum of Understanding) have been signed on a country-to-country basis. The integration of forces is going much further than it used to be and to a lower level than before. Examples of this, from a NLD Army perspective, are the following:

- Integration of 11(NLD) Airmobile Brigade (AASLT) “7 December” into the German Division Schnelle Kräfte.
- Integration of 43(NLD) Mechanised Brigade into 1(DEU) Panzerdivision.
- Integration of one German Tank battalion into 43(NLD) Mechanised Brigade.
- Planned integration of 13(NLD) Motorised Brigade with French forces.
- The BENELUX cooperation pact between The Netherlands, Belgium and Luxembourg.

Because of this deep integration, these units will train and exercise together on a regular basis. Even before integration these units were used to conduct their exercises in the most effective manner, by using their live simulation equipment. To keep enabling these units to use their live simulation equipment as an integrated unit, their respective systems will have to interoperate. To avoid having to build costly stove-pipe connections for each and every system-on-system connection, the use of interface standards is the most recommended and viable option, if not the only one.

1.3.3 The Power of Interoperability: The NOBLE LEDGER Case

If there is one case that shows what the UCATT standard can achieve, it is the NATO Response Force (NRF) exercise NOBLE LEDGER, held in the south of Norway in 2014. Goal of the exercise was to certify 1(GE/NL) Corps as HQ Land Component Command (LCC) for NRF-16. Secondary objectives were the integration of multinational artillery assets into the Multination Artillery Battalion, certification of the Royal Netherlands Airforce C-130 capability and finally to increase the cohesion within the Netherlands led IRF Brigade.

This use case will focus on the tactical exercise of the IRF Brigade, which was executed in the vicinity of the Norwegian training area of Rena. In total 5 manoeuvre battalions and 1 reconnaissance squadron took part in the exercise, led by 11(NLD) Air Assault Brigade HQ. Figure 1-3 shows the order of battle for the one-week exercise in which mechanised, air assault and airborne operations were executed. OPFOR consisted of one infantry and one mechanised infantry battalion, led by the Norwegian HQ North.

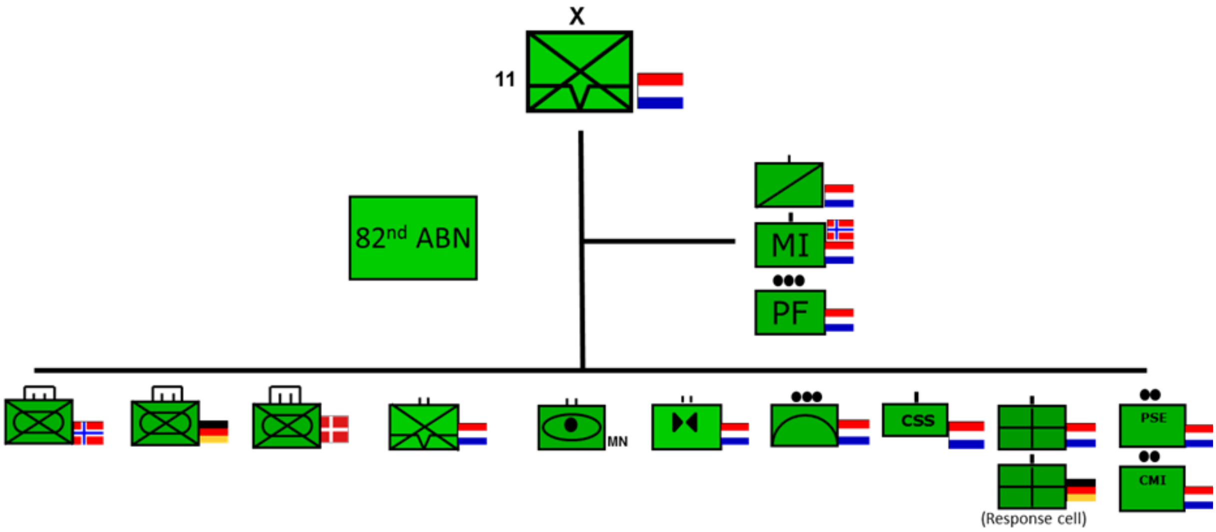

Figure 1-3: Order of Battle of the IRF Brigade During EX NOBLE LEDGER.

The simulation component in general consisted of 4 different (sub-) systems:

- The NOR NACMTC system, static;
- The NLD MCTC system, fully mobile;
- DNK vehicle DFWES equipment; and
- DEU AGDUS DFWES equipment.

In Annex B several interoperability issues are described, taking the UCATT functional architecture as reference. It has to be said that 3 out of 4 systems were from the same manufacturer. Even though this implies proprietary standards and protocols, this exercise still shows what interoperability between live simulations systems, UCATT's ultimate goal, can bring to tactical exercises.

NOBLE LEDGER was a unique exercise from a live simulation point of view. Never before had 4 systems interconnected to execute a Brigade+ level exercise. The last time so many different systems interconnected was during the 2010 UCATT proof-of-concept demonstration in Marnehuizen (NLD). Unlike the UCATT demonstration, which was purpose-built and took place in a laboratory setting, NOBLE LEDGER was an actual tactical exercise with much more players (2000+), little preparation time and more interfaces were used here. In total, interoperability was achieved on 6 out of 11 functional interfaces, where 7 would have been likely possible. In the end, a completely new CTC was built out of 4 separate ones in just a couple of days and with very little financial investments. This shows what can be achieved between systems from different manufacturers once the UCATT family of standards is in place. In this case a second manufacturer already was able to take part in this exercise using OSAG 2.0, the candidate for the future UCATT Laser Engagement standard.

1.3.4 British Army: Integrating a Cubic Deployable Tactical Engagement Simulation (TES) Combat Training Centre (CTC) with the US Joint Military Training Centre (JMTC), Germany

In 2012 it was directed that the British Army Training Unit Suffield (BATUS) that is based in Alberta Canada shall conduct the first exercise of the 2013 season at the US Joint Military Readiness Centre (JMRC) at Grafenwöhr (for live fire) and the US Joint Military Training Centre (JMTC) Hohenfels (for TESEX) range complex and the manoeuvre area lying between them. The TESEX phase ran May/June 2013.

A military requirement was that the quality of the training support, objective evidence gathered and after action review provided to the audience was to be maintained compared with that which would have been provided at BATUS; this was to be BATUS delivered training to BATUS standards.

Amongst other issues, this demanded that a similar level of training instrumentation, support and data analysis was to be provided to that which would have been delivered by the in-place AWES (Cubic supply) and DFWES (Saab supply) that constitutes the installed TES capability at BATUS.

In the absence of instrumentation and systems interoperability (the ultimate UCATT goal that one day might enable troop to turn up, turn on and go), it was necessary to investigate potential solutions to provide the required engagement, communication, tracking and analysis. Amongst the options considered, cost effective solutions included:

1) Use by the Battle Group (BG) and OPFOR of the full capability of the installed US TES equipment by adaptation where necessary and the full US Collective Training Establishment (CTE) infrastructure, accepting performance shortfalls such as reduced User experience, system fidelity and system limitations for data collection and thus subsequent analysis.

2) Use by the BG and OPFOR of a mix fleet of UK TES equipment for vehicles and US TES equipment for dismounts together with the full US CTE infrastructure, accepting increased cost and risk of the plan from the need to engineer vehicle TES interfaces to improve some aspects of system performance and fidelity.

3) Use by the BG of a temporarily established UK instrumentation capability (UK vehicle and man-worn equipment, a UK radio and data collection capability plus EXCON and supporting functions) but utilising some elements of the US CTE infrastructure (e.g., towers and communication bearers), and with:

   a) OPFOR provided by a UK force employing UK equipment using additional UK supplied equipment; or

   b) OPFOR provided by a US force employing US equipment using additional UK supplied equipment modified as required to fit US systems.

The selected method was 3b as it achieved, in addition to other benefits, the necessary instrumentation system performance, fidelity and data collection requirements, enabled simplified connection to other systems (such as that to provide distributed situational awareness for O/Cs and a Synthetic Wrap injection) plus the same experience for the trainees to that offered at BATUS.

To deliver this choice, whilst the delivery of the DFWES (Saab) element was straightforward, it was not quite so for the AWES (Cubic) element. To achieve a suitable outcome, considerable bespoke and specific engineering effort (including systems and component design, test and installation, integrations with extant infrastructure and system level testing) with the associated project and commercial management activity across multiple contracts was expended. In addition significant inter-agency liaison for permissions, access and approval to operate was needed. Each attracted costs, and whilst some costs would not re-occur if this was to be undertaken again, those reoccurring costs, is a significant disincentive to a repeat event.

Native system or component interoperability that UCATT seeks to enable would not eliminate all the required effort and resource consumption to deliver such instrumentation to support training, but would reduce the scope of the task, the associated risk to the plan and the time needed to enable the event.

1.3.5 British Army: Integrating a Saab Deployable Tactical Engagement Simulation Combat Training Centre with the Cubic Static Combat Training Centre on Salisbury Plain, England

1.3.5.1 Introduction

Between July and August 2011, the UK MoD conducted exercise PASHTUN DAWN 15 (PD15) on Salisbury Plain as part of pre-deployment training for units due to rotate into Afghanistan. What is described below are some observations of the interim arrangement for the instrumentation of that exercise that was established to cater for the circumstance where the numbers of live entities exceeded the in-place capacity. This arrangement was a stopgap measure whilst work to enhance the installed capability on Salisbury Plain was in process. However, it does demonstrate the work required to attempt to provide interoperability between two bespoke Combat Training Centres (CTCs) of different design (and in this instance each from a different manufacturer and being of different generations). Some of the limitations and failings encountered justify the long term goal of UCATT.

1.3.5.2 Background and Requirement

To support Mission Specific Training (MST) in preparation for operations in Afghanistan the PASHTUN DAWN series of exercises held on Salisbury Plain consisted of two BG scale events with OPFOR and civilian population supported by a full range of instrumented weapons and vehicles to inform detailed training mission analysis and After Action Review (AAR). The instrumentation requirement for PD15 differed from normal UK instrumented training in scale (numbers) and use of operation-specific vehicles. MST exercises were designed to enable two BG to train, one on the East and one on the West side of the training area with the audience augmented with 'cross-Plain' brigade troops and logistics support controlled by a notional task-force command. Each BG operated essentially in isolation from the other but there was movement of enemy, civilian and brigade troops across the entire area of operations.

Effective instrumentation of this exercise type was not initially possible with the installed capability on Salisbury Plain unless very significant exercise compromises were accepted mainly, but not entirely, due to the entity count. Work was in-hand to address shortfalls, but in the interim and for PD15 alone, funding was provided to undertake work to deliver an essential minimum capability which was to consist of a meld of CTCs systems to constitute a single larger capability.

1.3.5.3 The Systems Employed

Two systems were employed to create the required capability; the in-place UK Salisbury Plain CTC and a deployable CTC normally employed by the UK in Kenya (the Temporary Tactical Engagement Simulation In Kenya (TTESIK). The Salisbury Plain CTC itself consists of two Tactical Engagement Simulation (TES) systems: AWES, which is supplied and supported by Cubic Defence Applications and provides man-worn, small arms, vehicle tracking instrumentation, data gathering, comms plus EXCON and AAR facilities, which is used in conjunction with the DFWES appended precision fire weapon equipment supplied by Saab Training Systems (STS). This CTC was scaled for single BG level training events (and is similarly available in BATUS, Canada). For this Use Case it is appropriate to consider AWES the main element of the Salisbury Plain CTC.

In 2011 the AWES capability lacked formal generic vehicle instrumentation and could not support the numbers of entities intended for MST exercises. Thus AWES was supplemented for PD15 by the TTESIK system that was normally to be found supporting the British Army Training Unit in Kenya (BATUK) as a Deployable CTC. This was possible as the BATUK training schedule allowed time for TTESIK to be shipped to the UK for use on Salisbury Plain for PD15. TTESIK was (and remains) a Deployable TES system operated by STS as a managed service for the UK MOD and provides a full CTC capability optimised for training of light role forces up to BG level.

1.3.5.4 Integration

The early intent was to operate TTESIK and AWES as segregated systems with manual interaction/ intervention. But this approach did not meet the Army's training desire so additional funding was required to support a technical integration activity to address this. So Saab and Cubic were tasked to conduct integrations for the MoD with further advice provided by QinetiQ. The approach taken for technical integration was to minimise changes to the AWES system due to the older technology used (which would have added technical and timescale risk). So changes were mostly made to the TTESIK system along with middleware integration using the QinetiQ operated Architecture Independent Modelling Environment (AIME) toolkit. The main technical issues identified that required to be addressed were simulation and EXCON interoperability. In particular, five areas identified were:

- Laser simulation – At the time of the exercise AWES used a UK-bespoke version of MILES and the TTESIK system a UK-bespoke version of OSAG 1. These codes are non-interoperable but do use the same physical transmission layer, namely near infra-red, Class 1 lasers with matched detectors. As a result it was necessary to instigate a re-programme activity to enable TTESIK laser transmitters to operate on MILES.
- Real-time tracking integration – The Army required the ability to display and track all training activity in a single system, regardless of whether those tracked entities were using TTESIK or AWES instrumentation. The information exchanged had to be consistent between the systems as it was also going into other systems that rely on TES instrumentation such as ISTAR representations.
- Simulation support tools in the field – TTESIK has a field-able exercise monitoring tool that is a component part of the TTESIK system. AWES uses a similar system called AWES Distributed Situational Awareness (ADSA). Both these systems were to be available to observer/controllers. Exercise control on the ground was enabled using control or 'god' guns that had to interface with the AWES man-warn system, the TTESIK man-worn and all vehicles whether fitted with Cubic or Saab supplied equipment.
- ISTAR – The primary Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) simulation on PD15 was provided by QinetiQ's Synthetic Wrap team, using VBS2 and AIME. Unmanned Aerial Vehicle (UAV) products from this simulation were used to brief the training audience, so a consistent visualisation of events on the ground was key to training immersion.
- AAR – Each BG received an AAR from their respective training system, TTESIK or AWES. But cross-system visibility was needed to provide Higher Control (HICON) context and to brief cross-Plain activity.

1.3.5.5 Initial Configuration

The initial configuration for the combined system was as shown in Figure 1-4 below.

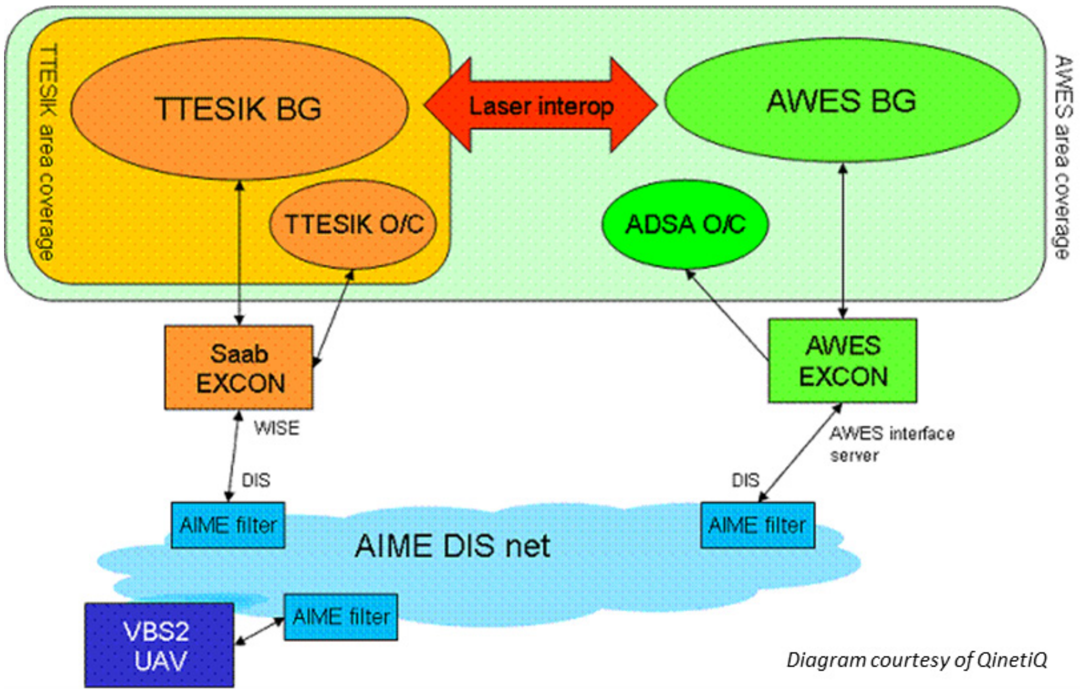

Figure 1-4: System Configuration.

This configuration had an exercise management burden as there was no automation of ORBAT information or player IDs. Thus Cubic and Saab staff were required to carefully manage EXCON information through version control and communication between each other. The configuration only provided real-time data transfer as the integration method used by AIME, AWES and TTESIK for data transfer was DIS and DIS is a real-time simulation protocol not designed to enable transmission of historic or 'latent' data that can be generated by TES equipment when fielded systems drop out of real-time connection with EXCON.

The arrangement did not provide interoperable operation of IED simulators as each system employed IED simulators with proprietary RF transmission to operate and there was no time or resource available to generate a technical solution. Similarly it was not possible to address the question of TTESIK equipped players being tethered to vehicles instrumented by AWES they mounted, nor was any Urban instrumentation integration attempted. This resulted in some orchestration of the exercise to mitigate these limitations.

1.3.5.6 Issues Encountered

The headline issues encountered were:

- Whilst the work needed to achieve laser interoperability was understood and laser code interoperability was achieved through using MILES, detailed investigation revealed the performance difference between the lasers and detectors of the two companies can create an 'unfair fight' situation with respect to probability of hit and effective range when mixed (i.e. a Cubic Small Arms Transmitter vs a Saab detector set, and vice-versa).
- It was swiftly apparent that despite being a known issue concerning player IDs, TTESIK fitted weapons were not achieving hits on AWES players due to poor initial ID management; it prevented correct operation until fixed.
- As initially employed the physical differences in man-worn systems of the two companies provided an easy way for the training audience to single out hidden OPFOR amongst civilians as the AWES version was identifiably different from the TTESIK one – even at long range. This resulted in

employment changes and the plan to have AWES equipped OPFOR operating amongst the TTESIK equipped western BG was dropped.

- RF spectrum and interference, especially operating in the licence-free spectrum and shows that unhindered use of that spectrum in new locations cannot be taken for granted.
- There were incidents where indirect fires created in AWES created unintended consequences in TTESIK. For example, on calling for a mortar strike on a platoon location, HICON specified that 2 to 3 individuals should be wounded or killed. The AWES fires desk has the ability to tightly control the effect size of simulated fires to achieve this effect. However, these control variables are lost in the translation to DIS and back into TTESIK. When the fire mission landed on the TTESIK equipped platoon, it was with the full potential of TTESIK's area weapons model. The entire platoon was killed, requiring a reset in order to continue with the exercise plan. In another incident, the AWES fires desk created a smoke round mission that would stimulate AWES vests with artillery warnings but not cause any casualties. This kind of control is useful to the exercise staff when they want to create a trigger event for a serial. Again, on transmission to TTESIK, there was a misinterpretation and the TTESIK system replaced smoke rounds with 81 mm high-explosive mortar rounds. Again, this resulted in unintended consequences. For this exercise the sub-optimal solution was to revert to separate fire mission control, coordinated by the AWES fires desk as a single point of contact for the military exercise controller. With indirect fires effectively being managed manually between east and west parts of the training area, the resulting system was loosely integrated on the ground. The automated interface points remaining were:
  - TTESIK laser interoperability with DFWES equipped vehicles, e.g., combat logistics patrols and brigade operations;
  - Common EXCON view of entity locations, states and hit events; and
  - Common deployed observer/controller view of entities via ADSA and TTESIK O/C terminals.

1.3.5.7 Lessons

As a result of this event lessons were identified across a range of areas including the management of the remaining PASHTUN DAWN series, future acquisitions and for the employment of deployable systems. These included the need for interoperability with exercise management systems and integration with Operational Command Information Systems to spectrum management, operational de-confliction and the need for caution when operating in the licence-free spectrum. In addition it was noted that the entity update rates were not always fast enough for effective stimulation of ISTAR serials and this should be addressed.

Of particular relevance to this Report are that:

- On one hand, proprietary interfaces were a costly hindrance yet on the other, solutions can be developed by industry to reduce these impacts. This effort showed there are significant benefits of having the ability to re-programme laser devices to support multiple code sets.
- This work proved there was more to interoperability for small arms than laser code and message formats, for example, once laser encoding issues are removed simulated weapon performance is influenced by other factors such as laser emitter beam propagation, detector sensitivity and firing vector dynamics over the time of the laser emission.
- The DIS interface as implemented was not found to be suitable for passing indirect fire missions (and other missions such chemical/biological/radiological contamination) between systems and a more suitable protocol is needed to pass such between TES systems in a consistent and predictable way.
- It was observed that AAR effectiveness had the potential to be degraded due to missing data caused by players not in real-time connectivity with EXCON. The solution to this in the future will be to adapt or adopt a simulation protocol to enable absolute time-stamping of reports.

1.3.5.8 Summary

The combining of AWES and TTESIK in the summer of 2011 provided a stopgap capability pending delivery of enhancements to the CTE on Salisbury Plain to support bespoke exercises for UK forces preparing to deploy to Afghanistan. It is difficult to predict what would have been achieved without the integration effort but there would have been little or no interoperability of EXCON systems, leading to completely separate BG exercises and AARs. It is possible there may have been some DFWES and TTESIK interoperability as both these components are designed by Saab. There would be no MILES integration of small arms and man-worn systems. But this experience has reinforced the UK requirement for native interoperability within design to meet UK training needs let alone the requirement to train with allies. A step taken toward standardised laser codes and backward compatibility to MILES has been taken and since 2014 all Saab products in service with the UK are OSAG 2 UCATT compliant. But the potential issue of an un-fair fight due to equipment performance of a mixed-supplier fleet difference remains.

1.4 WORKING METHODOLOGY

This section describes the process followed by the AG.

1.4.1 Staged Approach

The starting point for the AG was the UCATT-2 report delivered by MSG-063 which recommended work to elaborate on user requirements for urban combat training systems in the live domain and to draft a first series of standards to enable interoperability among different combat training systems.

The AG was able to make rapid progress, because many of its members had been involved in the predecessors LO2020, MSG-032 UCATT (also known as UCATT-1) and MSG-063 UCATT-2.

The first activity was to produce a roadmap, consisting of subjects to investigate and products to deliver during the mandated timeframe of the AG. These activities were mapped on the AG meeting schedule, which consisted of 3 meetings a year. This schedule is depicted in Figure 1-5.

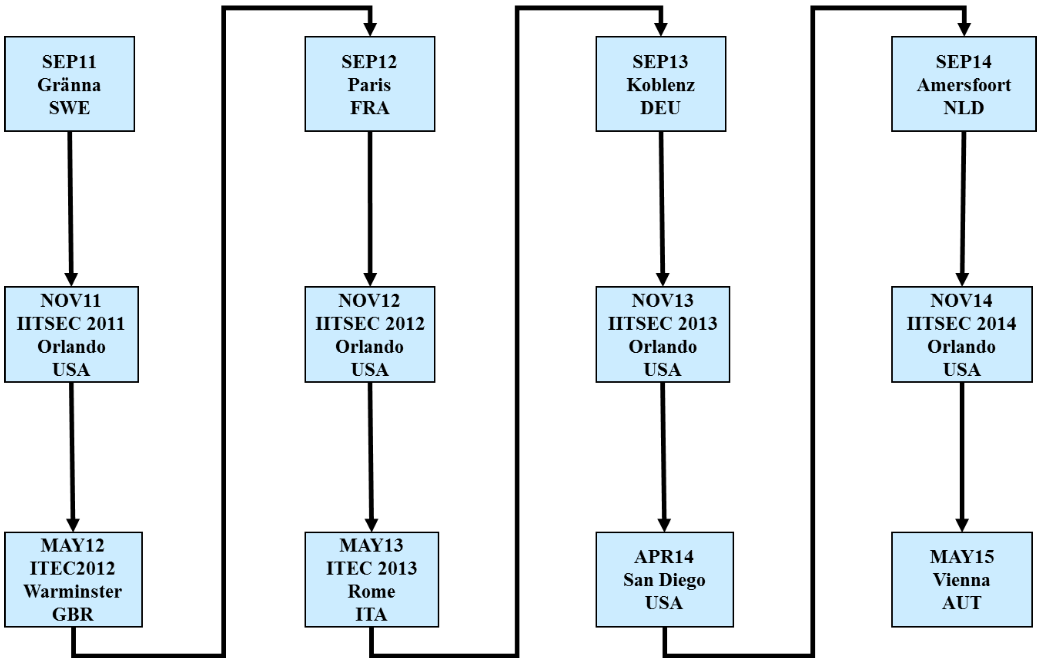

Figure 1-5: UCATT Meeting Schedule.

During the subsequent meetings the roadmap was checked and updated if required and proved to be a valuable tool for work management to ensure progress towards the end result.

In collaboration with the SG it was decided to first start working on the external interface that enables engagements between live dynamic objects. The AG therefore delivered a description of the data that has to be transferred (a superset of data elements) for the different types of engagements.

The SG was responsible for the specification of the physical implementation of this interface. They decided not to start from scratch, but to choose an existing code set as baseline, taking the drafted superset of engagement data into account. In order to perform this selection in a transparent and structured way, the AG and SG adopted a set of voting procedures, based on “Robert’s Rules”. For a definition of Robert’s Rules in the UCATT context see Annex K (UCATT’s Rules of Business). These rules were applied to select the base code set for the first UCATT engagement interface standard. The members of both AG and SG were involved in this voting process. As outcome the OSAG-2 code set was chosen as baseline.

After specifying the dataset for the engagement interface, the AG continued to specify the datasets for the other external interfaces. These external interfaces were identified in the UCATT Functional Architecture (UCATT FA), as designed by the UCATT-1 and UCATT-2 TGs. During this process, the interfaces and the architecture were analysed in more detail. This led to some minor changes to the Functional Architecture (FA) and the identification of a new external interface. The resulting FA and definitions of all external interfaces are described in Chapter 2.

1.4.2 Use of Existing Standards

The objective of UCATT is to identify and specify interfaces to enable interoperability among different combat training systems. It has been recognised that within NATO and SISO a number of (research) projects have been executed, or even are still progressing, that aim for interoperability among systems and have produced standards. Examples are DIS, HLA, JC3IEDM, MSDL, C-BML etc. Although initially many of these standards have been created mainly focussing on application in the virtual and/or constructive domain, they can also have value in the live domain. Therefore the UCATT AG was also tasked to evaluate the applicability of existing and/or developing standards in the UCATT FA. UCATT will seek to create a new standard only when no other suitable standard is available.

The AG considered several existing standards to assess their applicability for certain UCATT interfaces. This resulted in the identification of some promising candidates (see Chapter 3), together with recommendations to increase their functionality to meet certain UCATT requirements.

1.4.3 Interaction with NATO and Other Groups

MSG-098 UCATT Architecture TG was very closely linked to MSG-099 UCATT Standards TG. MSG-098 identified and prioritised candidate interfaces for standardisation through the SISO process. MSG-098 was also the “supplier” of the relevant Use Cases and the datasets for the standardisation process. Questions that arose during the work of MSG-099 were brought back to MSG-098 and feedback given.

In order to introduce a SISO Standard a SISO Product Development Group was established, consisting of members from both AG and SG. This ensured both technical and User aspects were addressed. PDG meetings were scheduled within the UCATT meeting calendar.

During UCATT-1 and UCATT-2 information about User requirements and best practises was exchanged between UCATT and the Training and Simulation Working Group (TSWG). During the UCATT-3 phase this useful interaction was disrupted due to change of personnel within UCATT and the transformation of the TSWG into MSG-116 Simulation Training and Operations Group (STOG).

When applicable, the AG called upon the expertise of other STO TGs, especially those involved with interoperability standards such as that the work of MSG-085 C2SIM which led to a briefing on MSDL, C-BML and JC3IEDM to assist AG work to assess these as potential candidates for UCATT interface standards.

The Interoperability User Community (IUC) is a SAAB led community of Users of live simulation equipment manufactured by SAAB. The purpose of which is to achieve interoperability between customers and to steer product development for Company and User benefit. A number of UCATT TG members are also active within the IUC, and this has facilitated the exchange of certain information including ammunition table data and details of the OSAG code. This has been a key relationship.

1.4.4 SISO Related Activities

Even though MSG-098 is a NATO NMSG driven activity, its focus is to define and prioritise interfaces to be standardised through the SISO process as mandated by STO. As the standardisation process has to be driven by a PDG which is formed by live simulation community (military, government and industry), the members of MSG-098 agreed to all join SISO and to subscribe to the UCATT PDG. The same applied to the members of MSG-099. Members of MSG-098 took the positions of SISO PDG Chair (Cpt Sander Cruiming) and Vice Chair (Mr. Staffan Martinsen).

For efficiency, SISO PDG meetings were aligned with the UCATT meetings and time allocated to SISO activities. But much of the development of the SISO Standard documents was done between the UCATT meetings. The SISO portion of the meetings was then used to conduct formal elections and balloting. This method of integrating SISO work into UCATT work has proved to work very effectively and should be continued in the future.

A problem that occurred was that the flexible method of working within the UCATT TGs sometimes conflicted with the structured procedures of SISO. This delayed the progress a lot and led to the fact, that a balloted UCATT standard could not be finished within the 4-year period of MSG-098. However, a draft UCATT standard is delivered to be balloted by the SISO community.

1.4.5 Benefit and Continued Involvement of Industry, Government and Military

The unique composition of the UCATT group with members from government, military and industry in the spirit of an open minded and cooperative collaborative working method creates a win-win situation for all participating parties. Governments and military users benefit from the experiences and knowledge of their respective counterparts and industry can give guidance on technological possibilities and feasibility. In exchange, the industry members get first-hand information on future User requirements and on government desired standards. The concept of a mixed group has been proved for over 10 years and should be kept for the follow-up activity.

1.5 RESULTS OF UCATT-3

The main task of the UCATT-3 TGs was to deliver at least one sub-standard to SISO. The first interface chosen to be standardised was the laser engagement interface. In order to achieve that goal and to enable the SG to deliver the standard for SISO review, several sub-tasks were formulated. Those sub-tasks are listed below, followed by the achieved results. Elaborations of those results can be found elsewhere in this report and in the attached annexes.

1) Revise the UCATT Functional Architecture as developed by UCATT-2:

   The AG revised the FA by checking it against the existing or plausible future use cases and known examples from practice. This was an on-going process throughout all AG activities, but most

examples were found in the process of creating the code-sets listed in Annexes E through H. By testing how a certain practical example fitted in the FA, necessary adaptations were discovered and the architecture updated. The resulting changes made to the FA can be found in Section 2.1.5.

2) Set requirements on the implementation of vulnerability models:

Considerable thought has gone into this issue, where the main question was if vulnerability models and vulnerability calculation itself would need to be standardised in order to achieve interoperability. It was decided by the group that from a technical perspective, standardisation of neither was necessary to achieve technical interoperability. From a fair-play perspective though, the issue is different. If a tank instrumented by system A fires at an vehicle instrumented by system B, the outcome of that engagement should be a reasonable and a logical one, even when both systems use different damage models and/or method of calculation. The AG decided to standardise the input (ammunition code) and the output (damage status) and consider the vulnerability to be a proprietary “black box”. The assumption here is that there is not that much difference in damage calculation that would lead to an imbalanced fight and a lack of fair play. In short: if the input is standardised, it does not matter if system A receives a 35 mm ammo code from system B or C because that ammo code would not differ from the code received from one of its “own” TES lasers. Assuming the national requirements of each individual system already lead to a logical and fair outcome when training on a national site, mixing systems would lead to a similar logical and fair outcome.

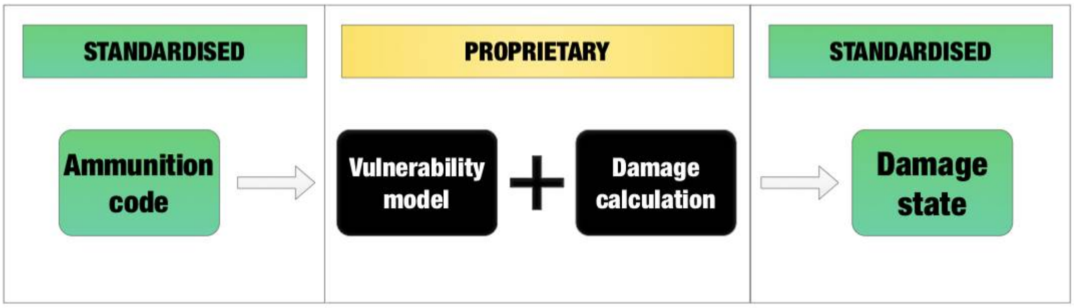

Figure 1-6: Concept of Vulnerability Model.

The damage states were built up in a parent-child structure, starting from the lowest common denominator (e.g., a MILES based system) as a base (level 1). This ensures both legacy system support, enable future growth and allow higher levels of fidelity if needed.

The ammunition codes were delivered to the SISO PDG as an annex and reference document to the UCATT laser engagement interface standard document. The agreed upon damage states can be found in Annex D.

3) Revise Use Cases as formulated by the UCATT-1, including non-kinetic effects:

The Use Cases that were formulated during UCATT-1 formed part of the basis for the UCATT work as to determine in which situations interoperability between systems was deemed necessary. The Use Cases are described in Chapter 2 of the UCATT-1 Report:

- USE CASE 0 – National Training on National Site;
- USE CASE 1 – Live MOUT Training Multinational Force on a National Site;
- USE CASE 2 – Use Other Nations Training Facility and Staff;
- USE CASE 3A – Distributed Combined Training;
- USE CASE 3B – Combined Training in Mission Area; and
- USE CASE 4 – Command and Staff training for Engagements in Different Mission Areas.

To ensure the activities of UCATT are still valid and focussed in the right direction, it is necessary to revise and validate all past results from time to time. The Use Cases were compared to the current situation and exercise demands within NATO and for each individual member country. The Use Cases were found to be still valid by the AG and no reasons were found to change them.

4) Set requirements for direct engagements between dynamic objects:

   Setting the requirements for direct engagements was probably one the most important tasks for the AG, as they would form the basis for the UCATT interface standard for laser engagement. This is also reflected in the prioritisation of interfaces (see Section 2.4).

   To formulate the requirements for direct engagements the AG took on the task of identifying the information and parameters that needed to be sent through that interface, enabling all thinkable current and future types of direct engagement. Direct engagements are engagements directly from player A to player B. The most obvious direct engagement is probably a soldier firing at another soldier, but also non-kinetic engagements (e.g., medical treatment) were considered.

   The training needs of the contributing nations were and are the starting point for the functional requirements made. One by one, each type of engagement was broken down into tables of parameters, including the required accuracy, unit or (geographical) system. These identified required parameters where subsequently handed over to the SG, who used them as requirements for choosing the UCATT optical interface standard. More on that subject can be found in the MSG-099 UCATT Standards technical report. The data sets can be found in Annex E.

5) Set requirements for the reporting of the status of a dynamic object:

   The requirements for reporting the status of a dynamic object were identified by analysing the (type of) information that a dynamic object needs to communicate, so that other elements, such as other players and EXCON, can observe the status or status change. This information is important for both online monitoring and for AAR purposes. The AG successfully completed this task and the results can be found in Annex F.

6) Set requirements for AWES (Area Weapon Effect Systems) implementation:

   Setting the requirements for the AWES function, or non-direct engagements, was very similar to the work done on direct engagements, with some specific differences unique to artillery, CBRN and engineering functionalities. The results of this task can be found in Annex E.

7) Set requirements for the integration of C4I systems:

   The integration of C4I systems in training systems is currently a “hot topic” and is pursued by many countries and manufacturers. This originates from the fact that military units rely more and more on systems like BMS (Battlefield Management System) for their situational awareness and tactical command. Training systems need to capture C4I system data for monitoring and AAR purposes. On the other hand, C4I systems need to be fed with training system data. This covers a usage of EXCON not identified before: cyber warfare injections. It also inevitably gives EXCON HICON (Higher Control) functionality, since those injections influence the tactical battle. Before, it was considered that EXCON monitored and influenced the technical status of the simulation system, but only monitored and logged the tactical exercise. The E7 interface allows influencing the battle by spoofing, giving misinformation or shutting down the C4I systems units rely on so heavily. Even though currently there are no known examples of cyber warfare being used in instrumented brigade level exercises or lower, the UCATT AG predicts this will happen in the future. This is a good example of how UCATT seeks to develop requirements and a standard that allow future growth.

   Results of the completion of this task can be found in Section 3.2.3.

8) Set requirements for EXCON capabilities and interconnections:

The system-to-system interface was one of the interfaces that made the UCATT-2 interoperability demonstration in Marnehuizen possible. It is still the most commonly used interface today when trying to make limited interoperability possible. Furthermore, this interface is used to connect other systems like virtual or constructive trainers and can be useful for LVC or "synthetic wrapping" purposes.

During its mandate UCATT has discussed possible candidates for this system-to-system interface, like HLA, DIS or TENA.

9) Elaborate contemporary example situations in relation to virtual and constructive simulations:

In its TAP and TOR UCATT identified that interoperability of live simulation with the virtual and constructive domain is very important. It was also recognised that already many efforts are being undertaken by others to set requirements and develop standards. Therefore further investigation was considered outside of the UCATT scope. However, to show the relation between the UCATT standard and LVC applications, a few current and relevant examples were described and added to this report and can be found in Annex I.

10) Set requirements for pairing and association of dynamic objects:

Analysis of interactions in a training system showed that weapons and dynamic objects need to exchange information, other than engagements. For example, it can be important to know who operates a piece of equipment or weapon, or if a player is allowed to or capable to operate that equipment or weapon. Also, damages to one object can result in damage to other objects, based on temporary relations or circumstances. The results can be found in Sections 3.3.4.3 and 3.3.4.4.

11) Set requirements for the interaction between the simulation system and real-life (weapon) platforms:

Since UCATT can only specify or propose standards for simulation systems and not for real-life platforms, this interface is considered a very difficult one. It is possible to set requirements for which type of information is accessible to the system, e.g., GPS positioning data or Laser Range Finder information. For actual standardisation however, an agreement with all or most platform manufacturers would have to be made. At this point this is considered to be an unreachable goal and would require too much effort, mainly because it is highly unlikely a 3rd party would get access to a vehicles' (e.g., main battle tank or infantry fighting vehicle) internal information network.

During MSG-098 the requirements for this interface have not been considered and may be a task of MSG-140 UCATT LSS.

12) Set requirements for the configuration of the live simulation systems:

UCATT defined an external interface to initialise the simulation system before starting the exercise. During this timeframe MSG-098 has focused on the ORBAT data, since the issues here are most pressing for contemporary joint and combined exercises: currently there is no interoperability and a lot of this data still has to be entered into the system manually, which takes a lot of time and effort.

To exchange ORBAT information, UCATT turned towards another (SISO) standard that already contains a lot of ORBAT data: the Military Scenario Definition Language or MSDL. Although the work is not complete, after scanning the standard the AG decided that MSDL is a good candidate for this interface. For other types of data the suitability of MSDL still has to be researched, which has been transferred as an activity to MSG-140 UCATT LSS.

13) Check APP-6(C) for missing symbols in relation to live (urban) training:

Most EXCON facilities use either 3D models or unit symbols in their graphical user interfaces. To standardise that symbology it was deemed logical to use NATO symbols, as prescribed in NATO

STANAG APP-6. This STANAG was written however from an operational perspective, not a training one. The military subgroup within UCATT has therefore performed a scan of APP-6(C) to see if there were any symbols missing for either Urban Operations or live simulated training. The results of that scan can be found in Annex J. During the coming MSG-140 UCATT LSS timeframe another scan will be made to see if in the (D) version of APP-6 some or all of these issues have been resolved. The remaining omissions will be handed over to NATO as an advice to be included in the next version of APP-6.

14) Investigate existing standards as candidates for each interface:

The UCATT Architecture Task Group does not stand on its own and is part of a larger SISO and NATO community that strives for standardisation. Some of the interfaces in the UCATT functional architecture connect to systems of which another MSG of SISO PDG has already made efforts to achieve interoperability. The C4I community is a good example of this, where considerable efforts have been made to enable C4 systems to interact with each other. It was therefore considered very likely that those standards already facilitate the UCATT needs to a large extent and were viable candidates for UCATT interfaces.

During the UCATT-3 timeframe members of UCATT-3 have actively promoted the UCATT standards, like for example Levels of Fidelity, NMSG symposia, SISO seminars and the Deutsche Gesellschaft für Wehrtechnik Training and Simulation Forum.

1.6 RECOMMENDATIONS

The recommendations of the MSG-098 work are outlined below:

1) Involve new countries and industries and re-engage with countries that have ceased earlier active involvement in the Group.

Rationale: Multinational training is increasingly important for the future with the trend for coalition operations. Technical interoperability of training systems, equipment and devices can assist in improving training effectiveness bringing with it operational benefit. A wider base of contributing nations and industrial entities with UCATT potentially leads to earlier and more widespread adoption.

2) Increase the "marketing" activities to create more awareness of the UCATT standard for live simulation systems within the User community.

Rationale: To create interest for further national involvement and adoption of UCATT standards by nations and industry awareness must be increased. This could be achieved by articles in magazines, papers, conference presentations, speeches, etc.

3) Reactivate the relationship between UCATT TG and STOG.

Rationale: In order to ensure a correct User perspective is held within UCATT, it is believed necessary to establish and maintain a close working or at least an effective communication between the two bodies.

4) Establish liaison between the UCATT community and the NATO and SISO efforts enhancing the JC3IEDM, C-BML and MSDL standards.

Rationale: UCATT will seek to create a new standard only when no other suitable standard is available. JC3IEDM and C-BML are likely candidates as baseline for E6 and E7, and MSDL for (a large part of) E11. However, these existing standards should also incorporate UCATT specific requirements.

5) Merge the standardisation and architectural activities together into the follow-up Task Group.

   Rationale: The anticipated benefits of the separation into two different groups did not materialise. Indeed the consequential increased administrative overhead has proven disadvantageous.

6) Continuation of the SISO membership funding for government members of MSG-140.

   Rationale: Having established a SISO UCATT standard, that standard must be maintained by a SISO Product Support Group (PSG). It is in NATO's interest to ensure a stable community is in place to do that and this can be achieved through this recommendation.

7) Consider the translation of the currently used functional architecture into the NATO Architectural Framework (NAF) if applicable and useful.

   Rationale: This will aid to verify the validity of the architectural approach in relation to physical implementations.

These recommendations have been recognised by STO and that the work of UCATT should continue for four main reasons:

- To continue the standardisation effort.
- To form the basis of SISO PSGs necessary for the maintenance and availability of approved interface standards.
- To acknowledge the applicability of the UCATT work is beyond just Urban training systems and applies to live simulation systems and Combat Training Centres and reflect this in the name of the follow-up activity (UCATT LSS).
- To accommodate the increased international interest in the interoperability opportunities UCATT can provide and invite other nations and participants (three additional nations will contribute to UCATT LSS).

The activity proposal was endorsed by the NMSG during the Business meeting in Oslo, June 2014 and was approved by the STB in September 2014 as MSG-140 UCATT Live Simulation Standards (LSS).

It was also determined that the scope of UCATT has been widened up from 'only' urban training systems to live simulation systems in general. This is reflected in the name of the follow-up activity UCATT LSS.

The TAP and TOR for UCATT LSS have been created during the working period of MSG-098 and can be found in Annex A.

Chapter 2 − THE FUNCTIONAL ARCHITECTURE

2.1 INTRODUCTION AND CHANGES DURING THE UCATT-3 PERIOD

2.1.1 The Capability Requirements Matrix (CRM)

It was recognised in 2003 that doctrine published by individual NATO/PfP countries did not support or identify joint or combined requirements for conducting effective military operations in an urbanised environment. Very few training exercises were conducted at the joint or combined level in an urban training environment. Countries had different requirements for the level of live training conducted from squad (4 – 8 personnel) through to Brigade level.

As late as 2006 urban training was not mandated by many of NATO and PfP countries. The first UCATT TG, as one of its tasks, sought to identify the needs of the different countries' training capability requirements, evaluate those requirements and make recommendations on a generic set of capability requirements for urban operations training in the Live, Virtual and Constructive (LVC) domains. In order to carry out this task a Requirements Matrix Sub-Group was established.

The purpose of the Capability Requirements Matrix (CRM) was to identify those components needed to support training at all levels from Squad to Brigade across the full spectrum of military operations, including military aid to civil authorities and cooperation with other governmental departments, international organisations and non-governmental organisations. Although it was initially intended to include all three environments only the live training environment was completed. The development of the CRM and its subsequent analysis was used to identify common elements, interoperability issues and where standards could be applicable in conducting (urban) live training. These were then addressed in a functional architecture and interfaces, through the definition of a common set of functional training requirements.

The capabilities identified in the CRM describe the requirements for a Combat Training Centre (CTC) from a user point of view. In order to derive from these capabilities, a generic set of requirements for the development of CTCs, it is necessary to have a common understanding of the training system from a system point of view. This means that there must be insight into the functions of the training system, how they are grouped together into components and what types of interactions take place between those components. Only then it is possible to discuss interoperability issues and compose the desired requirements. More information and the complete CRM can be found in Annex F of the MSG-032 RTO Technical Report.

In order to gain this insight and bridge the gap between the capabilities on one hand and requirements for the development of CTCs on the other hand, an architecture had to be created and agreed upon.

2.1.2 The Functional Architecture (FA)

Formally, an architecture is "the organisational structure of a system or component, their relationships, and the principles and guidelines governing their design and evolution over time" (IEEE 610.12). There are many different types of architecture, but two main categories are the functional and design architectures:

- A Functional Architecture (FA) is "an arrangement of functions and their sub-functions and interfaces (internal and external) that defines the execution sequencing, conditions for control or data flow, and the performance requirements to satisfy the requirements baseline".
- A Design Architecture (DA) is "an arrangement of design elements that provides the design solution for a product or life cycle process intended to satisfy the functional architecture and the requirements baseline" (IEEE 1220).

It was the purpose of UCATT to set requirements for interoperability, which is the ability of systems to exchange data, information and services to enable them to operate effectively together. At the same time, industry should have the freedom to propose and implement the most cost-effective solutions they can devise, as long as they satisfy the interoperability requirements. So, the UCATT main focus is on system interfaces. In this context, an interface describes the characteristics at a common boundary or connection between systems or components.

To identify and define the system boundaries and interactions with other systems (external interfaces), it is sufficient to create and analyse the FA of a CTC. This FA must be representative enough to cover all Use Cases defined earlier and the requirements from the CRM, while not touching specific design or implementation issues. The FA captures what the system can or might do, not how it does or should do it (e.g. the requirement, not the implementation such as communication which might actually be by wireless transmission or through a cable). The UCATT FA is illustrated in Figure 2-1.

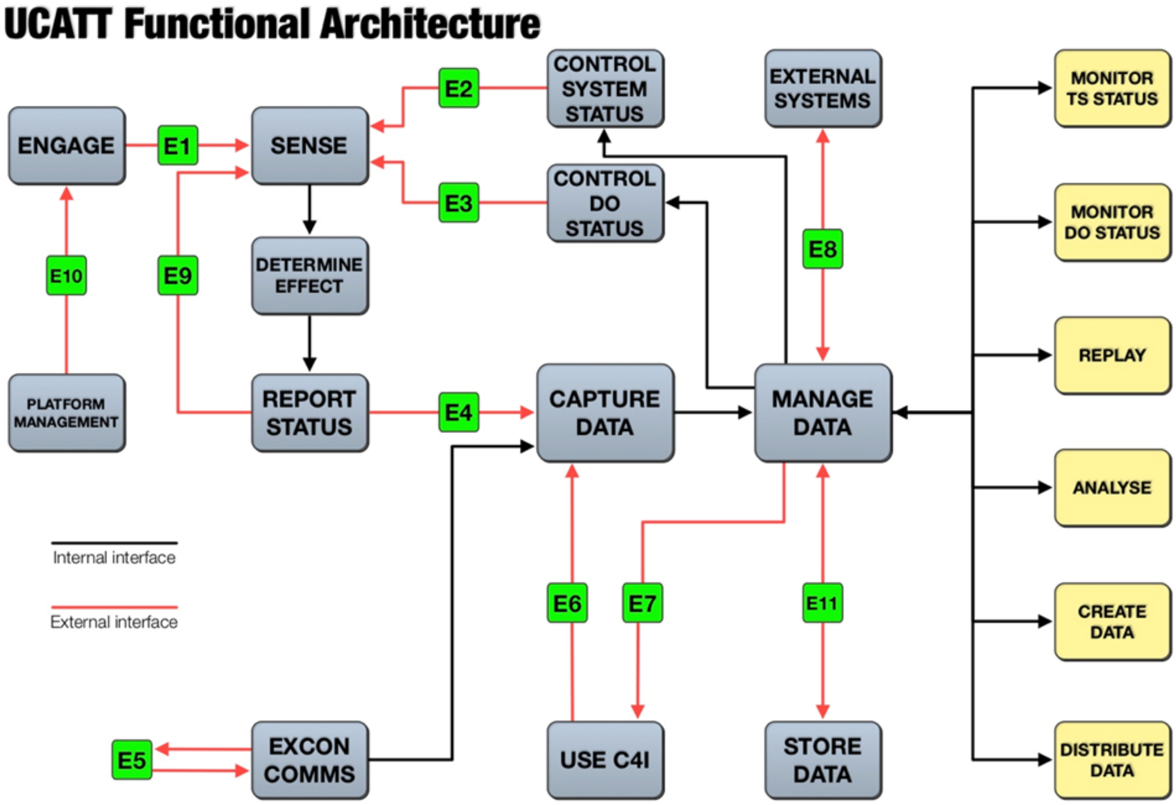

Figure 2-1: The UCATT Revised Functional Architecture.

Another subject of particular interest is the level of detail of the FA. Too few details will result in insufficient possibilities for interoperability, while too many details will result in losing oversight and identifying irrelevant interfaces for interoperability.

2.1.3 Internal and External Interfaces

In the case of the FA, an interface exists where data is exchanged between functions that reside in the architecture. While the complete FA describes and identifies all functions and interfaces that can be found in a CTC, it does not definitively identify the interfaces that need to be standardised to establish interoperability. In order to do that, a difference was made between internal and external interfaces.

Internal interfaces are defined as those that handle data communication that only take place in the system itself or a designated sub-system, whereas external interfaces communicate to either the outside of the system or to a system component that can be replaced by a non-native component (e.g., a Personnel Detection Device or Small Arms Transmitter from a different vendor). The internal interfaces where considered proprietary and out of scope for standardisation, since they were not mandatory for achieving interoperability.

By identifying the external interfaces, it is made explicit what interfaces need to be standardised to achieve interoperability. The external interfaces where subsequently give the designation "E", followed by an identifying number. From there on, these "Es" formed the basis of all the work done by UCATT-3, especially during the final delivery phase. A standard definition for each interface can be found in the sections and the annexes of this document.

2.1.4 Considerations Regarding the Functional Architecture

Special care has been taken in the definition of the architecture to allow for different implementations. For example, an engagement between a shooter and a target can be modelled in two different ways:

- Distributed solution: The shooter engages the target. Subsequently, the target senses this engagement through its "sense" capability and activates its "determine effect" capability. The resulting change of status is then reported.
- Centralised solution: If the "Determine effect" capability does not reside locally in a player unit, the result of engagements is determined centrally in the capability "Control dynamic object status". The data flow will then be: the target senses an engagement, the local "Determine effect" is not present or will have no effect, the target reports the characteristics of the engagement, which is captured and through "Manage data" provided to "Control dynamic object status". Alternatively, in implementations where the players have no sensing capability themselves, but instead the training system detects engagements, the sensing capability of the training systems determines that a player is engaged and provides the engagement characteristics to the central "Control dynamic object status" capability. That capability determines the effects of the engagement and subsequently provides the results to the target. The target senses the command to change its status, performs the status change and reports its new status, so other components of the system are aware of this.

2.1.5 Changes to the FA During the UCATT-3 Timeframe

The UCATT Functional Architecture was introduced in the UCATT-1 report (RTO-TR-MSG-032) and is still the basis for the continuing UCATT work. However, successive UCATT Task Groups have identified shortcomings or improvements. The UCATT-2 report (STO-TR-MSG-063) identified the need for two additional external interfaces E9 and E10. These interfaces were further investigated and detailed during UCATT-3. This resulted also in some adaptations to the FA and its interfaces:

- E9 was redirected (from "Report status") to "Sense".
- The function "Fire control" was renamed to "Platform control".
- An additional external interface, E11, was defined which incorporates part of the original E8 interface and the part of E9 that connected "Manage data" and "Create data".

The revised FA is depicted in Figure 2-1 above. In this figure, the red arrows represent the external interfaces, identified by an E-number. The black arrows represent the internal interfaces and their specification is out of the scope of UCATT standardisation.

2.2 KEY ELEMENTS OF THE FUNCTIONAL ARCHITECTURE

2.2.1 Functional Components and External Interfaces

For practical purposes, it is useful to distinguish several functional components within a UCATT training system. A functional component is a logical grouping of functions that are related to each other from a user's point of view. Although functional components do have a relation with physical components or facilities, it is not intended to influence the physical implementation or location of a UCATT training system. The breakdown of the training system into functional components serves purely to facilitate in defining interoperability. In the UCATT-1 report 6 main functional components were distinguished, 3 of them are extensively used in the UCATT-3 report: the Dynamic Object (DO), Exercise Control (EXCON) and Observer/Controller (O/C).

The second type of key elements of the functional architecture are the external interfaces. UCATT has identified 11 external interfaces (E1 through E11), which are described in the subsections below.

2.2.2 Dynamic Object (DO)

A Dynamic Object (DO) is defined as a live, virtual or constructive element in the training environment that:

1) Has a presence in the environment and either;
2) Has a valid status; or
3) Can influence the status of other DOs (execute engagements) or possesses both of these characteristics.

Ad 1 – **Presence**: a DO can be seen, observed or detected in the training environment. For example, a vehicle can be seen by the naked eye, observed in infra-red, detected by radar and be tracked by C4I systems and a CBRN area can be detected with specific sensors. Associated with its presence is its position. During an exercise the position of a DO can be dynamic (e.g. a soldier can move around) or static (e.g. a structure or feature which stays on the same position during an exercise).

Ad 2 – **Status** indicates the (level of) capabilities of a DO. It can be very basic (such as for example dead/ alive for human beings, or operational/destroyed for weapon systems and infrastructure), or it can be more complex, distinguishing between more levels of degraded performance. The status of a DO can be changed during and exercise, either resulting from engagements from other DOs or by (interventions from) the training system for exercise effect or administration. Although it could be required that a certain DO has a fixed status that cannot be changed rendering it "untouchable" or "indestructible" in an exercise. A typical example of such a DO is an O/C, whose status cannot be changed, yet it can engage other DOs.

Ad 3 – **Engagement**: A DO can influence the status of other DOs. For example, a soldier can fire an anti-tank weapon at a vehicle or at a building, a wall could be destroyed and with its debris it can engage DOs in its vicinity, and a CBRN area can affect unprotected DOs that enter it. However, examples of DOs that cannot engage are a pop-up target or an unarmed UAV, which is just a sensor platform.

2.2.3 Exercise Control (EXCON)

EXCON is the capability to define and (remotely) monitor and control an exercise. Generally this is done from a central location. For sake of simplicity, in this document it is also assumed that EXCON also contains the capability to analyse the results of an exercise and provide feedback to the trainees (in an After Action Review (AAR)), and the capability to monitor and control the training system itself, necessary to support the training exercise (System Control).

2.2.4 Observer/Controller (O/C)

An Observer/Controller (O/C) is the capability to monitor, influence and evaluate an exercise by distributed, local means. It is a role in the training area played by exercise staff. The O/C component might seem a logical part of EXCON. They share much functionality, but the O/C capability also has some other functionality that clearly distinguishes it from EXCON.

In addition, an O/C is also a DO. The O/C is present in the simulated battlefield and can engage other DOs, either by directly changing their status or by imitating engagements from a virtual actor.

2.2.5 External Interface Descriptions

The UCATT external interfaces describe a number of transactions; each type of transaction is mapped on one or more transportation methods, requiring a physical interface.

2.2.5.1 E1 − DO Engagement (Engage ⇒ Sense)

This interface represents an action of one DO on (one or more) other DOs, with the purpose to change the status of that other DOs. The engagement contains only the characteristics of the action, not the resulting status of the affected DOs, the resulting status has to be determined based on these engagement parameters.

Examples:

- Direct or indirect fire from a shooter to a target;
- Explosion of a mine, possibly affecting the status of DOs in its influence sphere;
- Medical treatment of a medic on an injured person; and
- Repair action by a maintenance engineer on a damaged vehicle.

2.2.5.2 E2 − Training System Status Change (Control Training System Status ⇒ Sense)

This interface controls the technical status of a DO, enabling its functioning in the training environment. Through this interface it is possible that a DO is initialised, reset, calibrated etc. It also accommodates the distribution of an (altered) terrain representation or damage models for systems that require this data at decentralised nodes, for example in each DO for determination of engagement effects.

2.2.5.3 E3 − DO Status Change (Control Dynamic Object Status ⇒ Sense)

Through this interface the (simulated) operational status of a DO is affected by other sources than engagements by DOs. This interface implements:

- The direct change of DO parameters, such as its operational status or logistic supplies. This can be a direct action of an O/C, for example a reset, or the distribution of the outcome of an engagement that is centrally evaluated (typically in EXCON). This interface is required for geo-pairing systems and for training systems that centrally simulate engagement areas such as for example artillery areas.
- The distribution of certain engagement parameters, so that the proper audio and/or visual effects can be triggered locally at the DO, even though the engagement outcomes are centrally determined and provided to the DO (e.g., a DO that is affected by artillery fire is provided with the new status, but also with the type of ammunition and distance of impact, so the proper audio effects can be generated by the DO).
- The distribution of engagement parameters to the affected DOs to determine the outcome of the engagement locally at the DO level. This functionality is required when the (primary) triggering of

an engagement is centrally determined, but the determination of the outcome is also dependent on information that is available at the DO level but not (e.g. for latency reasons) in EXCON. Examples are virtual engagement areas created in EXCON, such as minefields, fire support target areas and CBRN areas. EXCON can determine that a DO is engaged by an engagement area, but the engagement outcome also has to take into account local parameters such as protection factors (e.g. wearing armour, CBRN mask) or attitude (e.g. standing or prone).

- The distribution of the characteristics of engagement areas (such as fire support target areas, minefields and CBRN areas), so the triggering of engagements with these areas and the subsequent determination of the resulting outcome can be done locally at the DO level.

2.2.5.4 E4 − DO Reporting (Report Status ⇒ Capture Data)

A dynamic object reports its (change of) status through this interface to the rest of the world. The status contains for example operational status, location, supplies, engaging or being engaged, etc.

This interface exists in different physical domains, for example the communication of the status to:

- EXCON (typically radio communication); and
- Players, including visual presentations (smoke, lights) or sounds (explosion).

Remark: The interfaces to trigger the physical devices (for example pyrotechnics when shooting or being hit) are considered internal interfaces.

2.2.5.5 E5 − EXCON Communication (Use EXCON Communication ⇔ Use EXCON Communication)

This interface enables the communication between training staff members of different systems operating in the same exercise. It covers:

- Voice radio communication; and
- Exchange of for example electronic notes, pictures, and video.

2.2.5.6 E6 − Receive C4I Data (Use C4I ⇒ Capture Data)

This interface transfers data from C4I systems to a UCATT training system. This includes Battlefield Management System (BMS) functionality such as a report from a scout that an enemy vehicle has been detected or a graphical sketch showing the situation. This data can be stored in the training system for analyses purposes and can be used during AAR.

2.2.5.7 E7 − Send C4I Data (Manage Data ⇒ Use C4I)

This interface transfers data from a training system to C4I systems. For example, an operational overlay created by the training staff and used in EXCON can be distributed to the C4I systems of the troops that are training. It could also be possible that the training system provides status information of (simulated) entities (either “live” dynamic objects or “virtual” players) to the C4I systems.

2.2.5.8 E8 − Event Data Exchange (Manage Data ⇔ Interface with External Systems)

This interface enables the exchange of data between systems, which can influence the course of the training session and generally has a dynamic, time critical character. Examples of event data exchange are (updates of) status of DOs and the creation of a minefield in one system (System A), which is communicated to another (System B).

2.2.5.9 E9 − DO Association and Pairing (Report Status ⇒ Sense)

This interface enables the logical linking of objects in the training environment; this includes linking of DOs amongst each other (DO association) and linking equipment that is not modelled as a DO with DOs (equipment pairing). Examples are:

- Personnel mounting and dismounting vehicles;
- Personnel or vehicles entering or leaving (parts of) buildings; and
- Personnel picking up weapons.

2.2.5.10 E10 − Exchange Platform Data (Platform Management ⇔ Engage)

This interface enables the exchange of data between the training system and computers (such as the fire control system or platform management system) of the instrumented real systems. This is a bidirectional interface. Data exchange from the platform to the training system is used to enable or influence the behaviour and the engagements of the DO in the training environment. Examples are selected ammunition type, dynamic lead, environmental parameters and relevant vehicle parameters.

Data exchange from the training system to the platform is used to influence the behaviour of the real platform, for example providing the platform with target distance information delivered from the training system in case of a laser based training system, visualising tracers and fall of shot in the visual sensors or adding sounds to the communication systems (e.g., explosions, messages for training purposes).

2.2.5.11 E11 − Reference Data Exchange (Manage Data ⇔ Store Data)

This interface enables the exchange of data that is generally used for reference purposes, e.g. the transfer from System A to System B of an ORBAT definition, damage model definitions, geospatial (terrain) data such as the layout of a building composed of separate walls, a created scenario or a recorded exercise. It generally contains non-time critical information and is therefore used mostly prior to an exercise, but it can be used during the execution of an exercise.

2.3 MAPPING FROM FUNCTIONAL TO PHYSICAL

2.3.1 The OSI Model

The OSI (Open System Interconnection) model defines a networking framework to implement protocols in seven layers. Control is passed from one layer to the next, starting at the application layer in one station, and proceeding to the bottom layer, over the channel to the next station and back up the hierarchy.

The OSI model is a conceptual framework made to understand complex interactions that are happening. The OSI model takes the task of internetworking and divides that up into what is referred to as a vertical stack that consists of the seven layers as depicted in Figure 2-2.

Since the UCATT FA describes where data is exchanged between systems or components, the OSI 7-layer model applies. To achieve interoperability between functions it is therefore necessary to address not just the data that needs to be sent but also the physical implementation of how that data is transmitted (e.g. laser or radio in the case of E1).

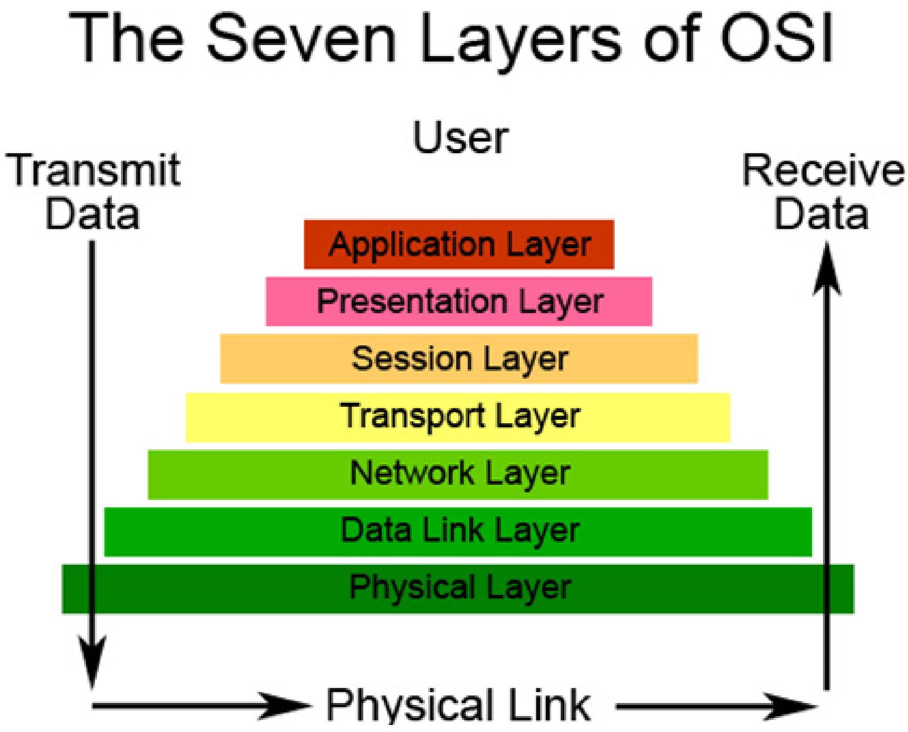

Figure 2-2: The Seven Layer OSI Model.

2.3.2 The Relation Between External Interfaces and Internal Interfaces

The AG specified the requirements for interoperability at the application level; these are called the E-interfaces (Es). The SG translated the functional, external interfaces into the lower levels, down to the physical layer. These are called the I-interfaces (Is).

When going into the physical layer of interfaces in a system, functional interfaces (Es) are implemented by physical interfaces (Is). The aim of the UCATT group is to define and standardise a set of physical interfaces to allow interoperability between systems in the live simulation domain.

It should be noted that a physical interface can be found in several functional interfaces. For example, the laser interface (I2) is used for direct engagement simulation (E1), DO technical or operational status control by the O/C using an umpire gun (E2 and E3) and for indoor positioning (E3).

As of this report the identified links between functional and physical interfaces are summarised in the table below.

Table 2-1: The Identified Relation Between Functional and Physical Interfaces.

		E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11
I1	Long Range Radio (LRR), DO to DO	X										
I2	Laser	X	X	X								
I3	Short Range Radio (SRR)	X										

		E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11
I4	IR – short range											
I5	TBD											
I6	TBD											
I7	TBD											
I8	TBD											
I9	TBD											
I10	Serial interface between TES and radio modem		X	X	X							
I11	Long range radio, DO to EXCON		X	X	X							
I12	Ethernet, NC to EXCON				X							

When looking at actual simulation systems from the point of view of physical interfaces a physical architecture emerges, showing the physical implementation of functions. Figure 2-3 below gives an example of a physical architecture. This example is purely for illustrative purposes and is not intended to dictate system design. As mentioned earlier in this report, the intent of UCATT is to enable flexible system design, enable industry to fulfil their customers' needs, while still achieving UCATT interoperability.

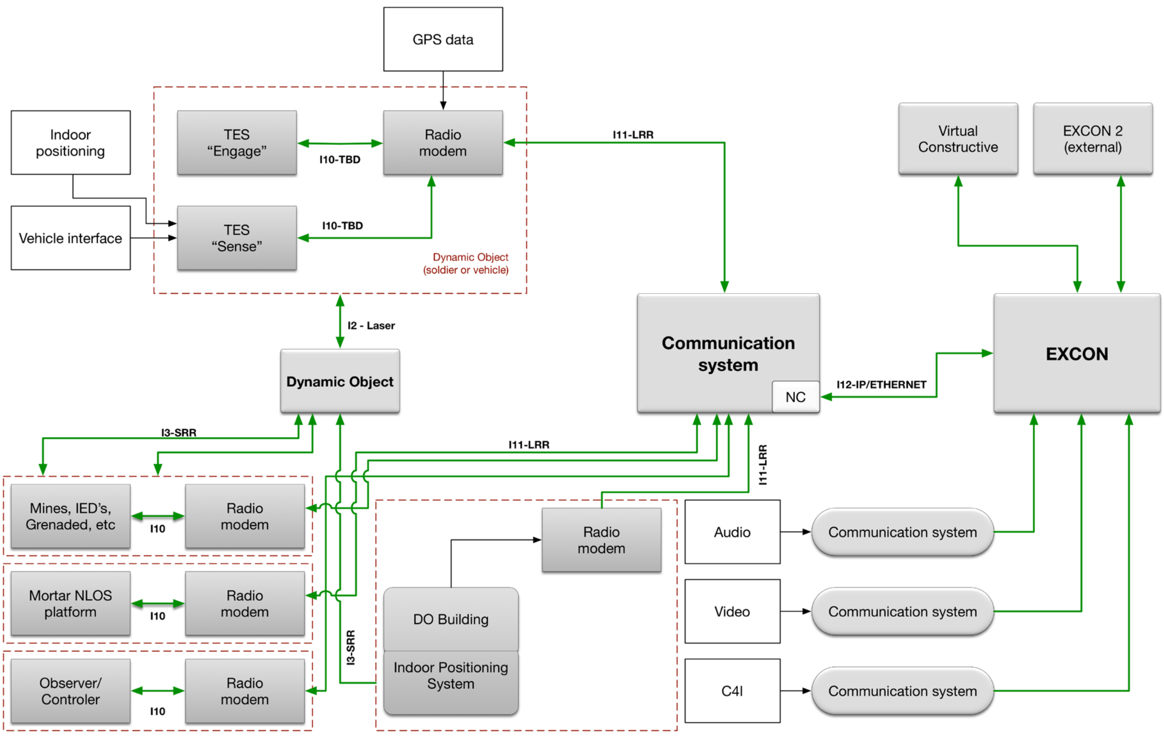

Figure 2-3: Example Physical Architecture.

2.4 PRIORITIES FOR STANDARDISATION

2.4.1 Introduction

The UCATT TG has identified a total of 11 External Interfaces. It requires a substantial effort both in manpower and in time to define a new standard for each interface. Although for some UCATT external interfaces existing standards can be used, it is unrealistic to expect that the whole family of UCATT standards (in one or more of their physical implementations) can be defined simultaneously. Therefore the UCATT TG decided to prioritise the sequence in which standards for external interfaces will be developed, both in terms of functional interfaces and of physical interfaces.

2.4.2 Priorities for the Functional Interfaces

The priorities for development of standards for the functional external interfaces are driven by User requirements, taking the Use Cases as reference. This prioritisation and the underlying arguments are described below:

1) The first priority of standards to develop was the **E1** interface. The engagement between dynamic objects of different training systems is the most basic functionality required. Interaction of players in the field is essential to all identified Use Cases. Different training systems have different architectures and different ways to implement engagements. Two totally different implementations are for example systems using line-of-sight engagements (such as laser) and systems using the geo-pairing mechanism. This requires different physical implementations of the E1 interface. It was decided to first define a standard for laser based systems (E1/I2), because this type of system is currently widely used by many nations, who already operate and train together, and who have a requirement to use their training systems in joint and combined exercises.
2) Closely related to enabling engagements, is the ability of dynamic objects to report their status and the results of such engagements, both to the players in the field and to the EXCON(s). Therefore the **E4** interface is the second priority.
3) The third priority is the ability to set or influence the status of dynamic objects from the EXCON of another training system. This requires the **E2** interface (training system status change) and the **E3** interface (DO status change). It is assessed likely that E2 and E3 will be mapped on the same physical interface, that only the dataset will be different and that both interfaces will be defined simultaneously. Therefore E2 and E3 are listed together as priority 3.

With E1 through E4 implemented, it is possible to use DOs from different training systems in the same exercise, without requiring their own EXCON capabilities. Only one (local) EXCON is required to monitor and control the exercise and to create AARs. This would substantially reduce the technical and logistical efforts to facilitate a joint and combined exercise.

4) The next priority is to enable data exchange at the training system level, for example to exchange data between different EXCONs. This is the **E8** interface. With this interface it is possible that all involved systems can display all relevant information in a synchronised way, resulting in a complete and up-to-date operational picture of the exercise. In addition, this interface can contain functionality to control DOs of another training system through their own EXCON. E8 can be defined to include the E2, E3 and E4 functionality. Having E1 and E8 implemented in this way, it is possible to use DOs from different training systems in the same exercise, however requiring all related EXCONs to be present and interconnected. In fact, the successful UCATT demonstration in September 2010 used parts of E1, E4 and E8 to show the potential of the UCATT standards.

The remaining external interfaces have a lower priority. The **E9** interface enables the logical linking of objects in the training environment, such as linking DOs amongst each other (DO association) and linking

DOs with equipment that is not modelled as DOs (equipment pairing). The **E6** and **E7** interfaces enable the interoperability of training systems and C4I systems. It is likely that the main effort to define these standards will be driven and performed by other standardisation groups. The UCATT TG should remain connected to these developments to ensure that live training system specific requirements will be incorporated in those standards. The **E5** interface enables the communication between training staff members of different systems operating in the same exercise. It is likely that commercially available standards can be used for this interface. The **E11** interface enables the exchange of non-time critical reference data, facilitating exercise definition and initialisation and exercise evaluation. It is likely that also for this interface existing standards can be used. Finally, the **E10** interface enables the interaction between the training system and the (computers of the) operational platforms. This interface is a complex one, because it must accommodate many different platform specific instances.

2.4.3 Priorities for the Physical Interfaces

As can be inferred from Table 2-1, three types of physical interfaces were identified for the implementation of E1. History and technological development presents the laser optical implementation as the most simple and effective method of simulation of ballistic effect in the kinetic battle. This places the Laser as overwhelmingly most common form of E1 and it is on that basis the Laser physical interface (I2) was chosen as the priority.

Through time, Industry have developed the techniques and various encoding implementations that are now in-service. The selection of which by individual procurement authorities is likely to be a strong function of the acquisition timeframe (thus code availability) and particular beneficial characteristics (and limitations). The work of the UCATT Standards Group (MSG-099) has been to establish a most suitable code for the UCATT Interface Standard for Laser Engagement.

Against the data requirements set out in this report, the MSG-099 determined that the development of a completely new coding was inappropriate for multiple reasons including cost and timeframe. Instead it was decided to analyse the most common codes to determine their applicability for development to meet the operational and interoperability requirements of today and the future. The codes selected were MILES, OSAG, NCL and COSIM.

Each code was analysed with particular reference to the required engagement data, potential for interoperability with extant coding and further growth and development potential. In addition the analysis included consideration of other engineering and operational factors impacting combat system design such as the impact upon receiver sensitivity and emitter power, range and propagation and performance in different weather conditions, eye safety and issues such as the ownership of the Intellectual Property. Physical characteristics, data handling capability and protocol used informed the full analysis to the point that enabled the selection of OSAG 2.0 Standard as the baseline UCATT Interface Standard for Laser Engagement during 2012. The selection was made by vote of eligible UCATT members in accordance with the UCATT Rules of Order. Members were asked to consider a balance of issues ranging from technical features and capability, to investments and the installed base.

Some key features of OSAG 2.0 that make it attractive as the baseline for the UCATT Interface Standard for Laser Engagement include its short pule and transmission times that lead to limited energy and improved laser safety (typically Class 1) and low transmitter battery consumption, its good scaling capacity (for the number of small arms, heavy weapons, and ammunition types), efficiency and reliability via error detection/correction and potential for future expansion of transmitted parameters (as GPS coordinates).

Further information regarding the codes reviewed and work subsequent to the 2012 selection may be found in the report for MSG-099.

The second functional external interface to define a standard for, is E4, the DO reporting function. This interface transfers information from a DO to other parts of the training system, typically to EXCON. Referring to the UCATT Use Cases, the need for the external interface E4 arises when trainees use another nation's training site and training facilities (the host site), while bringing their own operational equipment and their own Tactical Engagement Simulation (TES) equipment. When information has to be transferred from the TES equipment to the host system's EXCON, a number of solutions can be implemented (see also Figure 2-4):

- Option 1, the host system provides each DO with a radio that has to interface with the visiting TES equipment. This physical interface is called **I10** and typically requires a serial interface.
- Option 2, the visiting DOs bring their own radios, connected to or integrated in their TES equipment. The visiting radios now have to communicate with the host's radio system. This physical interface is called **I11** and requires a long range radio interface.
- Option 3, the visitors also bring their own radio communication system, possibly with masts to establish a full coverage of the training area. In this case, E4 is located between the visiting system's radio network controller and the host EXCON. This physical interface is called **I12** and is typically implemented through an Ethernet interface.
- Option 4 is the combined solution, where a DO is equipped with both his own and a host system's radio (I10), the radios can communicate with both radio systems (I11) and also the radio network controllers can interface with both EXCONs (I12).

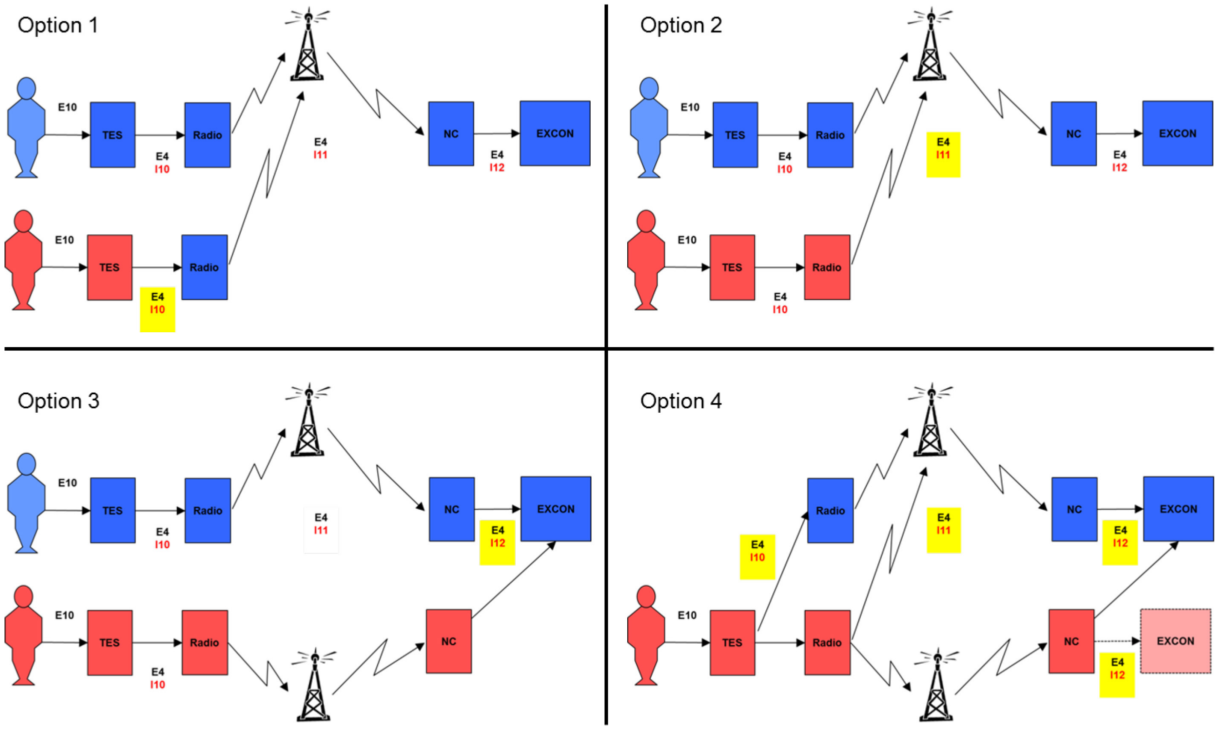

Figure 2-4: Different Options for Physical Implementation of the E4 Interface.

The implementation of I10 as physical interface for E4 requires that the TES must be able to interface with different types of radio. The predominant advantage of this solution is that one automatically complies with the local communication regulations (e.g. bandwidth, frequency, power, voltage). However, this solution requires additional hardware, the extra radios for the host system need to be provided either by the visiting troops or by the host system. A disadvantage is that there possibly can be a quality of service mismatch

between the TES and the other radio system (e.g. a different update frequency). Also, in this situation where only one radio is used, only the host EXCON can be used, possibly leading to a loss of capabilities of the visiting's training system. Furthermore, some training systems use radios as relay to communicate with EXCON (short range and long range). Such a requirement would demand a custom solution.

The implementation of I11 as physical interface for E4 requires that radio frequencies and power must be standardised and harmonised. Within NATO there are provisions for enabling this. An advantage is that this is an "air" interface, it does not require additional and/or extra cables, plugs, power, power management, batteries etc. It is also logistically very easy to support. However, in this situation only the host EXCON is used, possibly leading to a loss of capabilities of the visiting's training system.

The implementation of I12 as physical interface for E4 requires that the visiting troops also bring their own communication system, which therefore must be mobile and transportable. This can be an expensive solution and might result in challenges regarding radio coverage and frequency management at the host's site. In this solution there is a choice to use one or more EXCONs, but if only one EXCON is used, there can be a loss of capabilities of one of the training systems.

Given these arguments, from a user point of view I11 is the most preferable physical implementation of E4. It is most efficient related to costs, logistics, frequency management, user friendliness and fidelity between the participants. The next best option is I10 and I12 comes in last place, because this solution requires a fully mobile training system.

Having multiple physical interfaces (I10, I11 and 12) allows for maximum flexibility and can preserve more advanced capabilities when the host system has less.

Chapter 3 − STANDARDISATION

3.1 DO DYNAMIC MODEL

The DO dynamic model is the mechanism that determines the new status of a DO based on its current status, its properties and an engagement affecting the DO. A common name for the dynamic model is also vulnerability model. The name "vulnerability model" might suggest that this model only determines the effects of weapons but this model also takes care of repair and medical activities (thus reversing the status towards a more operational level). Also resupply engagements can be part of this model.

Generally, the DO dynamic model is triggered by an engagement and will determine the resulting change of DO status (if any). However, the status change mechanism can also be more complex, without directly changing the operational status of the DO. One example is a time-dependent function: when a wounded or contaminated person is not or wrongly treated, the effect(s) can become worse and the patient could eventually die. Such a mechanism can also be implemented for vehicles: when not repaired or maintained it might further degrade.

Another example is that multiple engagements are required to change the status of a DO. When one bullet is fired at a structure such as a wall, it will probably not be damaged or destroyed. However, when multiple hits of larger calibre bullets are fired at the wall, it may become damaged or even destroyed, so only the cumulative effects will change the status.

To be UCATT interoperable in respect of the DO dynamic model, a training system must satisfy two conditions:

1) The input to the model must be standardised and those requirements are listed in the datasets of the external interfaces.

2) The output of the model (the result of the engagement) must be standardised and the definition of this output (the DO status), is provided in Annex D.

If the input and output sets between two systems are not the same, a mapping must be made. The definition of model output and a mapping between different levels of detail are provided in Annex D.

When satisfying these two requirements, technical interoperability is enabled and the DO dynamic model can be considered as a black box function. It is still possible that two training systems with different levels of statuses can interoperate. When each training system is responsible for determining the results of each engagement on its own DOs, not even a mapping between the statuses is required. However, when a training system must change the status of a DO from another training system with a lower level of detail of statuses or when the statuses of DOs must be monitored in a training system with a lower level of detail of statuses, a mapping is required.

There are two ways to map a detailed status to a higher level status:

1) The lower level status is mapped onto the higher level associated status, such as the mapping of a "main gun kill" onto the more general "weapon kill".

2) The lower level status is discarded (or mapped onto the current status of the DO), such as the mapping of a "secondary weapon kill" onto "operational", since the main gun is still operational and therefore a "weapon kill" is too strong.

Under these conditions each training system can use its own DO dynamic model. Those models can be based on the same mechanism (e.g., kill probability look-up tables) but using a different dataset, or they can be based on totally different principles. Even when they use the same type of mechanism, differences can occur

due to level of detail. For example, a common mechanism to simulate different levels of protection on a DO, and thus different outcomes of an engagement, is a 3D representation of a DO. Some systems use a simple representation, for example a rectangular box, distinguishing only front, back, left, right, top and bottom. Other systems can make use of far more complex representations, distinguishing maybe hundreds of polygons, each with different values for protection and possible outcomes of an engagement. As long as the input and output are standardised, the systems can interoperate.

However, from a User perspective, interoperability also requires a certain level of "fair fight", that means that the results of engagements between types of DO within and between the training systems, must be statistically and tactically comparable. If an engagement between a DO from System A on a DO from System B will consistently give different results than that of the same engagement between the same types of DO from System B and A, the interoperability of the systems will lose its credibility and thereby it usefulness.

A fair fight can be ensured by using the same DO dynamic model and the same dataset or by tuning the DO dynamic models of the involved training systems. The consequences of the differences in DO dynamic model from different training systems must be analysed in the context of training objectives and based on that comparison, the commanders must decide to accept the consequences or not (and thus not use the mix of training systems). This will be a case by case decision.

3.2 EXTERNAL SYSTEMS

3.2.1 Definition of External Systems

External systems in the UCATT context are those systems that are not an integral part of a particular UCATT training system and with which the training system equipment must interface. Examples of external systems are: another (UCATT) live training system, a virtual or constructive simulation, a C4I system and a weapon system. When instrumented by the training system, a weapon system becomes part of the exercise, but from the UCATT training system perspective it is an external system.

3.2.2 Live − Virtual − Constructive Simulations

The current level of technology allows for a deeper integration of simulation systems into a single simulated battlefield. Most countries are pursuing LVC (Live, Virtual, Constructive) programmes of some kind. The purpose of LVC is to leverage the strong points of one domain to fill gaps in another. In those cases data is either injected into the live simulation system from virtual or constructive systems or vice versa. Therefore UCATT has made efforts to anticipate the possibility of not only connecting to other live simulation systems, but also virtual or constructive simulators.

The most likely method of connecting to non-live simulators is considered to be through the E8 interface (Event Data Exchange). Although decisions have not been made for that interface, existing standards like HLA, DIS or TENA have been investigated and are considered viable candidates to achieve LVC connectivity. Illustrations of such arrangements can be found in Annex I.

3.2.3 C4I Systems

From a training point of view and possibly for reasons of cost-effectiveness, it is desirable that trainees can use their operational C4I systems in a UCATT environment, instead of being provided with simulated equipment only used for training purposes. The external interfaces E6 (receive C4I data) and E7 (send C4I data) enable the training system to exchange information with such operational C4I systems.

There are several example situations for the implementation of E6 and E7.

3.2.3.1 Logging and Replay of C4I Data for Monitoring and AAR Purposes

The data from C4I systems is captured and typical examples are:

- Record the relevant data in order to be able to reconstruct the recognised common operational picture, generated by the C4I system, at any moment in time (e.g., status of entities/units, overlays, orders, reports). This must be synchronised with the other data in the training system.
- Retrieve who created certain data (e.g., spot reports, orders).
- Retrieve which user was accessing what information at a certain moment in time ("snapshots" from every user) (only if this information is recorded in the C4I systems).

In many cases operational C4I systems do not possess functionality to log and/or replay the above mentioned data elements. In these cases this functionality must be provided by the training system. It requires at least the functionality of the training system to receive C4I data (E6) and when the operational C4I systems are involved in the replay, also the functionality to send C4I data (E7).

3.2.3.2 Synthetic Wrap, Feed Information from the Training System into C4I Systems

An exercise with live players can be enriched by virtual entities. In the case of a full integration, live and virtual players should be able to interact with each other. On the short term, this scenario is not the driving force for UCATT, since it requires some innovative technical solution to enable live players to observe virtual players (both visually and through sensors) and interact with them. The other way around is technically less complex. However, there are already implementations of virtual and live integration, where live players can observe virtual entities and the effects they produce and can even interact with those virtual entities. For example forward observers, who are equipped with special binoculars through which they can see virtual planes and helicopters, and observe the results of simulated fire support. Or soldiers who can engage virtual targets in shooting houses, where the targets are projected on the walls. See Annex I for a further description of these examples.

But even if live and virtual players cannot observe each other, there is a good reason to connect a live training system to virtual and/or constructive simulations. It enables the live play to be embedded in a much larger context, with simulated flanking and higher level units. The live players can be made aware of this larger context by messages on their radio nets, but can also monitor the presence and activities of virtual or constructive entities on their C4I systems. This requires an interface from the training system to the C4I systems (E7).

It is recognised that not all information of virtual and constructive entities should be indiscriminately exchanged with the C4I systems of live players. Instead, some filters must be implemented, because for example it is not desirable that live players get (automatic) position and status updates of the simulated enemy.

Another example of this Synthetic Wrap functionality is that the C4I systems are provided with certain characteristics of (selected) simulated engagement areas, such as minefields and CBRN areas. These simulated engagement areas are defined in and managed by the training system (EXCON). There might be situations, for example when EXCON also acts as higher control, that the training staff has to provide the C4I systems of the trainees with for example the location of a minefield or a contaminated area. This kind of data typically ends up in specific overlays used by the C4I system. The distribution of this data is can be prior to an exercise, as part of the scenario definition, but engagement areas can also be created and changed during the execution of an exercise.

The easiest way to transfer this type of data is to copy the data from the training system by manually entering it into the C4I system. However, this can be laboriously and prone to mistakes. Another solution is to transfer

information of engagement areas from the training system directly into the C4I systems, avoiding discrepancies between data in the training system and data in the C4I systems. This requires the E7 interface. What data (which characteristics of which engagement areas) is transferred when must always be under training staff control.

3.2.3.3 Feed Information from C4I Systems into the Training System

Transferring information the other way around, from C4I systems into the training system is also a possible example situation. For example, the trainees can lay a minefield in the live training environment and define its location in the C4I system. The existence of the minefield must also be known in the training system, especially when the training system is responsible for detecting engagements between the (simulated) minefield and DOs and/or for determining the results of such engagements. This data can be provided to the training system prior to an exercise or during its execution. Another example is a call for fire, entered into the C4I system used by a forward observer or a Fire Support Coordination Centre to direct fire.

Also here there are several ways to implement this data transfer:

- Manually by the training staff where training staff read the data from the C4I system and it is entered manually into the training system ("swivel chair interface") so that a difference between the data in the C4I systems (e.g., the perceived location of a minefield) and the actual data (e.g., the real location of the emplaced mines) can be created.
- Semi-automatically, on command of the training staff, whereby the exact data from the C4I system (e.g., a call for fire) is transferred into the training system, but the training staff decides on which data will be transferred and at what time (requires the E6 interface).
- Automatically, the data is real-time transferred from the C4I system into the training system (e.g., orders to units or entities), without control of the training staff.

3.2.3.4 Cyber – Training System Influencing C4I Systems

Cyberspace, or shortly cyber, is defined as the digital environment, consisting of computer equipment and services. The use of digital assets by the military is evolving strongly. Be it in weapon systems, command and control systems or in logistic and administrative systems, they are increasingly becoming an integral part of military operations, accelerating processes and forming a critical capability. Besides the use of dedicated military equipment, the military are also directly or indirectly making use of civil digital infrastructure, like telecommunication networks and power grids. At the same time, the growing dependence on digital assets also creates vulnerabilities. Therefore, cyberspace has developed into the fifth domain for military operations, along with land, air, sea and space.

Cyberspace can be subdivided into several layers. A simple model consists of three layers:

- The lowest layer is the physical layer, consisting of the hardware and physical infrastructure of cyberspace, such as the computers, routers, cables, storage devices, etc.
- The middle layer is the logical layer and makes the physical layer work consisting of operating systems, software (applications) and data that is stored on and processed by the physical layer.
- The top layer is the social layer, consisting of the people and organisations that make use of cyberspace.

The layers are closely connected and cyberspace can only function when all layers interoperate. Nevertheless, the main point of action for cyber-attacks is the logical layer. By intruding in and interfering with the logical layer, effects can be achieved in other layers. For example, changing the mechanisms of Supervisory Control and Data Acquisition programmes, hardware can be forced to malfunction or even

sustain physical damage. On the other hand, interfering with the logical layer can change the data and services provided to the end users, possibly influencing their behaviour, the ultimate goal of cyber-attacks.

In cyberspace one's own digital assets must be protected (defensive cyber operations) and the digital assets of an opponent might be attacked (either for intelligence or offensive cyber operations).

The effects that can be achieved in the logical layer of cyberspace, that must be maintained and protected in own systems and must be disrupted in systems of an opponent, can be categorised as:

- **Confidentiality**, unauthorised gaining access to information from digital systems, such as when an opponent is able to look at the operation plans stored in a battlefield management system.
- **Integrity**, unauthorised manipulation of data or functionality of processes, such as when an opponent is able to change the location of an entity displayed on a battlefield management system.
- **Availability**, unauthorised affecting the availability of data or the level of service of processes, such as when an opponent can disrupt the data exchange or completely block the functioning of a battlefield management system.

Cyberspace is present in the urban battlefield, even at the lowest level. Units and even individual soldiers are relying on computerised systems for situational awareness, command and control, communication, navigation and engagement of an opponent.

Although the offensive use of cyber means is planned and probably executed at the strategic level, units in the urban environment can be subject to its effect. Even at company or platoon level, disrupting or corrupting C4I systems or platform management systems may have major impact upon unit effectiveness. Because it is likely that future units and individual systems can be subject to cyber-attacks and because of the severity of the resulting effects on performance, there is a need to train units and commanders in a live training environment to deal with cyber warfare and the loss of functionality of computerised systems.

Therefore it is desirable that cyber injects can be initiated from the training system (EXCON) into operational C4I systems. Possible injects may include:

- Disrupting the integrity of the information, such as changing entity location data or changing the information displayed on overlays.
- Disrupting the availability of data or functionality, such as freezing the user-interface or blocking information being exchanged.

Some effects of cyber-attacks can readily be mapped on certain damage statuses, such as "C4ISR kill", "BMS computer kill" and "Data communications corrupted".

The UCATT assumption is that the involved C4I systems must have a built-in capability to handle simulated cyber incidents for training purposes. This capability is therefore outside the scope of UCATT.

The AG also identified that interfacing with other systems has information security aspects, but they are not explored, neither is protecting the cyber security of the training system itself addressed by the AG.

3.3 EXTERNAL INTERFACE DEFINITIONS

This section describes the main subjects and principles that were explored during the definition of each External interface (Es). The detailed specification of the data elements that are part of an interface, are listed in the Annexes.

3.3.1 General Remarks

An External interface transfers the required data between two system functions. The dataset of each External interface is defined as a "superset", that means that the set contains all possible data elements to support the different interactions between the two system functions and also different system designs, where functions reside in different parts of the system and therefore require different mechanisms for data transfer.

An example of the former at the level of detail of the UCATT FA might be an engagement which is an event from outside a DO that can change the status of that DO. There are many different types of engagement. Being hit by a bullet, being exposed to a CBRN area or being repaired, are different types of engagement, and thus require different data elements. But all these data elements are part of the engagement interface. An example of a comparison of different required data elements for different types of engagement is given in Table E-2 in Annex E.

An example of the latter may be where functions reside in different parts of the system and therefore require different mechanisms for data transfer. For example, to simulate the hit of a bullet, a totally different dataset is required in a system based on one-way line of sight engagements (e.g., laser) than in a system based on geo-pairing. An example of this comparison is described in Table 3-1. Thus the term "superset" is used to express that for a specific interaction between two system functions, generally only a subset of the defined data elements are required as opposed to the complete list. In the definition of the supersets, the relevant subsets are distinguished.

Table 3-1: Example Engagement Datasets of Different System Designs.

One-Way Line of Sight Method		Geo-Pairing Method	
Shooter ID	(green)	Shooter ID	(green)
Shooter location	(red)	Shooter location	(green)
Shooter velocity	(red)	Shooter velocity	(green)
Weapon type	(red)	Weapon type	(green)
Weapon direction/angle	(red)	Weapon direction/angle	(green)
Ammunition type	(green)	Ammunition type	(green)
Engagement range	(red)	Engagement range	(yellow)
Terrain	(red)	Terrain	(yellow)
Affected DO ID	(yellow)	Affected DO ID	(green)
Affected DO location	(red)	Affected DO location	(green)
Affected DO(s) velocity	(red)	Affected DO(s) velocity	(green)
Trigger time	(red)	Trigger time	(green)
Impact time	(yellow)	Impact time	(yellow)
Point of impact	(yellow)	Point of impact	(yellow)
Projectile impact velocity	(yellow)	Projectile impact velocity	(yellow)

3.3.1.1 Time

Time related to data transfer within the training system must be based on a common reference time, for example GPS time.

3.3.1.2 Time Stamps

It is assumed that all messages transferred via the external interfaces are labelled with the time they were generated or received.

3.3.1.3 DO Identifications (IDs)

These are the unique identifications of DOs and used by a training system to distinguish the different DOs. These IDs are also important to maintenance personnel of a training system. But to operational users of a training system, like trainees and O/Cs, the DO IDs are generally not meaningful, especially when dealing with personnel and vehicles where Users are generally more interested in the associated call sign. It is assumed that a training system has the mapping of DO ID and call sign available.

The requirement to accommodate at least 100,000 DOs in the live environment is given in Annex C, and determined by analysing the number of DOs per category (type of unit) for a brigade against brigade reference exercise. However, the numbers per category are not intended as a constraint against each category. It is assumed that the DO IDs are interchangeable across the categories: only the grand total is relevant.

It is recognised that when operating in a mixed live, virtual and/or constructive environment, the total number of DOs can be significantly larger than 100,000, for example when wrapping a live Brigade level exercise in the context of a virtual or constructive Division or Corps level operation. It is possible that live and virtual DOs can interact, for example a live soldier fires at a virtual target within a shooting house or a virtual airplane drops a bomb on a live vehicle.

The requirement regarding the number of DOs only addresses the number of DOs (be it live, virtual or constructive) that are relevant for the live training system (in this case relevant means that a live DO can influence other DOs or can be influenced by other DOs).

3.3.2 Influence of System Design on the Definition of External Interfaces

As stated, the data elements from the defined supersets that are actually transferred, depend on the system design. To illustrate that different transfer methods require different datasets, the table below shows a possible mapping of a contact engagement of a shooter hitting a target with a rifle on two types of transfer methods: a transfer method based on a one-way line of sight transfer (e.g., laser) and a transfer method based on geo-pairing.

The data elements are divided into three categories:

- The data element is transferred as part of the engagement within the training system (green).
- The data element is not transferred as part of the engagement, but taken into account by the training system (yellow), for example because the data element is registered by the affected DO(s).
- The data element is not transferred, it is not taken into account by the training system, but it still can influence the simulation (red). For example, in a simple one-way line of sight system, when the affected DO receives the engagement data, the engagement is considered successful. However, even though in this case the terrain and DO locations are not transferred and not taken into account by the training system, the physical (live) terrain can block the transfer, thereby influencing the engagement.

The difference between these two methods can be explained by the fact that the one-way line of sight method makes use of the characteristics of the live physical environment, while the geo-pairing method resembles more a virtual simulation.

The one-way line of sight method sends a directional signal containing the shooter ID and the used ammunition type. This signal can be detected by another DO, which can determine the time and point of impact and the projectile impact velocity, based on the received data. Much of the required data for the engagement is implicit, because reality "automatically" takes care of it: if the weapon is not directed at a target, the signal will not reach the target and therefore the target will not be engaged. A physical object in the terrain can block the transfer signal, more or less simulating the blocking of a fired bullet.

The geo-pairing method needs to know much more of the physical environment to simulate an engagement. At the moment of a shot, the system must have available all relevant characteristics of the shooter (ID, location, weapon type, weapon angle, used ammo type) and that of all other DOs (ID, location, velocity) to determine if they are affected or not. Also, the system must know the exact configuration of the physical terrain to determine if the bullet hits a target, misses a target or is stopped by a physical object in the terrain.

Typically the properties of the terrain, weapons etc., are not transferred at each shot, but are loaded into the training system before exercise execution.

3.3.3 Implementing Interoperability

3.3.3.1 Levels of Fidelity / Detail of Simulation

Depending on the training purposes it is possible to simulate the activities and effects of non-ballistic and non-line of sight weapon systems at different levels of detail. In many cases the most important objective is that the effects of these weapon systems can be simulated, while simulating the exact activities and procedures to achieve those effects is of less importance, as long as fairness of the fight can be ensured. Skill training is typically done outside the scope of tactical exercises.

For example, there are several ways to simulate the use of mortars in a live urban environment:

- A simple approach is that a fire support request is issued by an observer. That request, sent through operational C4I systems, ends up at a fire control centre. If the request is granted, a fire support mission can be executed directly from EXCON, not requiring any action of actual mortar systems that could be present in the physical environment.
- A more integrated solution could be that the order for the fire support mission is sent through the operational C4I system to a mortar unit in the physical environment. Once they are in position and ready to fire (so involving mortar crews and taking into account real C2 procedures, time and location parameters), EXCON is notified, who subsequently executes the fire mission. This notification can be done simply by radio, but it can also be envisioned that the mortars are in some way instrumented, so that they can provide the trigger for the start of the fire mission.
- A better integrated solution could be that the mortars provide their settings to the training system, including a trigger when a mortar grenade is fired, so that the actions of the mortar crew define the execution of the fire mission in the training system, without any additional action from EXCON.
- An alternative solution could be that the order for the fire support mission is sent through the operational C4I system to a virtually simulated mortar unit, for example a mortar simulator.

For the training objectives of the forward observer and the personnel influenced by the effects of the fire mission, the first solution could be sufficient, while having instrumented fire support weapon systems provides additional training value for the personnel in the fire support chain. In addition, the manoeuvre unit can be confronted with mistakes made by the fire support crews, like wrong timing, location and/or ammunition.

3.3.3.2 Interoperability

Implementing interoperability has at least two aspects from a functional point of view, commonality of models and adequacy of data transfer:

- **Commonality of Models –** If two systems have different types of models, they still can be interoperable, either by using only the greatest common denominator or by defining a mapping between the models. Take for example a system which uses 4 different operational statuses of DOs (e.g., operational, mobility kill, fire power kill, total kill) and a system which uses many more statuses, having several stages of mobility kills (e.g., track or wheel fallen off, axle broken, engine destroyed) and several types of fire power kill. It could be agreed that when interoperating and directly setting the operational status of a DO of the other system, the second system only uses 4 of its operational statuses (in fact adopting the model of the first system), or otherwise that a mapping is made between the different status (e.g., that all mobility kills of the second system map onto the one mobility kill of the first system and that the mobility kill of the first system maps onto the mobility kill − engine destroyed of the second system). Which procedure to apply must be agreed upon before operating together.
- **Adequacy of Data Transfer –** The sender must provide the receiver with the (minimal) dataset so the receiver can perform its function. What that dataset is, depends on how and where in the system data is processed. So, for example in case of a direct fire engagement in a laser system, the weapon direction and angle does not have to be part of the transferred engagement data for the target to determine the effect of the shot, while in a geo-pairing system the weapon direction and angle must be part of the engagement data for the system to determine the effect on the target.

3.3.4 E1 − DO Engagement

3.3.4.1 Types of Engagement

In the UCATT context an engagement represents an action on a DO. For the definition of the E1 interface, different types of engagements were examined and specified:

- **Contact and Proximity Engagements –** A contact engagement is one where a projectile hits the target, e.g., a bullet or an anti-tank high explosive round. A proximity engagement is where the ammunition does not hit a target, but it explodes in the vicinity of a target and thereby affects it, e.g., an ammunition with a time or proximity fuse.
- **Missile Engagements –** These are closely related to contact and proximity engagements, but the flight trajectory and mode of control require extra parameters.
- **Minefield Engagements** – A minefield is a collection of mines located in the same area. They can be simulated as individual mines, either physically placed in the live environment or virtually simulated in the training system (“EXCON”). In both cases the interaction with these mines is a contact or proximity type engagement, covered by the first case listed above. However, there are also training systems that simulate a minefield as an area without simulating each individual mine wherein a DO has a certain probability of getting struck by a mine while in that area designated. Simulation of individual mines is more realistic but for backward compatibility reasons the implementation of minefields as probability areas is taken into account. This includes the creation of minefields, effect of minefields and the clearing of minefields.
- **Fire Support Engagements –** A fire support target area is the 3-dimensional space where the ammunitions of a fire support mission deliver effect. This covers mortar or artillery fire or aerial bombardments. When fire support is modelled as (a series of) individual munitions, the interactions with the ammunitions are contact or proximity engagements. Fire support can also be simulated without simulating each individual projectile such as where a DO has a certain probability of getting

engaged by a delivered projectile. The implementation of fire support target areas as probability areas is taken into account in the definition of the engagement interface.

- **CBRN Engagements –** A CBRN area is an area which contains a toxic agent and can affect DOs. CBRN areas come in, at least, two forms:

  1) A contaminated area, which is static and sticks to the ground, infrastructure and other objects; or

  2) A cloud, which is dynamic and due to the influence of atmospheric conditions (wind, temperature, humidity, etc.), changes its location, shape, size and density (and therefore its effect) over time.

  A CBRN attack can result in both a static contaminated area and a dynamic cloud. The creation and deactivation of CBRN areas and being affected by CBRN areas is taken into account. Also the creation and deactivation of CBRN decontamination areas and the interactions with DOs is considered in the engagement dataset.

- **Energy Weapon Engagements –** Energy weapons emit energy and thereby can influence Dynamic Objects. There are two types of energy weapons:

  1) Weapons that emit one burst of energy, like for example a (nuclear) Electro Magnetic Pulse (EMP) or a flash-bang grenade, which generates simultaneously an intense flash of light and a pressure and strong sound wave. The interactions with these types of weapons can be modelled as a contact or proximity engagements.

  2) Weapons that emit energy for a certain amount of time. Typically the start and end time are under user control. For example sound waves or micro waves can be generated by a weapon when it is activated and the energy emission stops when the weapon is deactivated (trigger released). When the emission stops, also the influence stops. The emission of this type of weapons requires a new engagement definition. When energy weapons emit energy during a certain timeframe, it is important to note that many of the engagement parameters can change during the engagement. For example, the shooter and target(s) can move, the direction of the weapon can change and maybe even the energy level can change.

- **Non-Lethal (or Less than Lethal) Weapon (NLW) Engagements –** The purpose of NLW is to temporarily incapacitate the target. So the major difference with other types of weapons is that their effects are temporal; they do not require an explicit repair or healing or medical action. There are many types of NLW, however, their use can be modelled by the mechanisms and datasets covered by the types of engagements described above.

- **Jammer Engagements –** Jammers are devices that generate a "bubble" of electronic noise that disturbs the signal by which a Radio Controlled IED (RC-IED) is initiated, thereby preventing it from detonating. Also, as side effect, a jammer can hinder or disturb the radio communication of DOs that are located in the generated bubble. The activation, deactivation and interaction with jammers are taken into account in the engagement dataset.

- **Repair and Medical Activities –** During operations (minor) damages to vehicles and large weapon systems can be repaired in the field, either by the crew themselves or by Combat Service Support units. Similarly, wounded personnel can be treated in the field by other (including medical) personnel. These repair and medical activities greatly influence the tactical operation: they consume resources for execution, they require protection, they take time and the results of the activities influence the combat power of a unit. Therefore it is important that these functionalities are taken into account in the specification of the engagement dataset.

- **Logistical (Resupply) Activities –** During exercises supplies are consumed and replenished. Registering and analysing ammunition consumption and resupply activities must be supported by

the training system and are therefore incorporated into the engagement dataset. Resupply activities can be performed by resupply vehicles or by members of EXCON, including O/Cs in the field.

- **Imitated Engagements (by Observer/Controller) –** An O/C performs many functions and this can include acting as a part of the EXCON function for administrative purposes with the affected DO aware of this intervention. It is also desirable for the O/C to be able to alter the status of a DO directly and without the affected DO being aware of the O/C intervention. As such an O/C, acting in that EXCON capability, requires the ability to imitate the engagements listed above with appropriate ammunition, etc. If for regular E1 engagements the affected DO is notified of the origin and nature of the engagement, the DO will be provided with spoof information as specified by the O/C. The data required for the imitated engagements is part of the engagement dataset.

Urban operations are not exclusively the task for ground based forces, but are generally conducted by joint forces, incorporating aerial and naval forces. Typical relevant example situations from the air domain have been analysed in order to derive possible additional requirements regarding the UCATT interfaces and definition of engagement data: these appear in Annex E. It was concluded that interactions with aerial and naval forces are fully covered by the datasets already defined.

3.3.4.2 Propagation of Engagements

Propagation of an engagement occurs when one DO is engaged and as a result of that engagement, the DO itself engages one or more other DOs. Those subsequent engagements can be the same type as the original one, sometimes with altered parameters, or it can be different types of engagements. Typical examples are:

- A bullet hits a wall, flies through it and hits another DO. In that case the wall initiates a contact engagement with the same ammo type and depending on the type of material of the wall, with different velocity parameters (mainly a lower speed).
- A bullet hits a wall, ricochets and hits another DO. The wall initiates a contact engagement with the same ammo type but also with a different direction.
- An explosive grenade hits a wall, the wall is destroyed and a DO nearby is affected by the debris from the wall and/or blast of the explosion. Upon destruction the wall initiates a proximity engagement with debris from the backside of the wall. It can also initiate another proximity engagement in front of the wall.
- An explosive device (e.g., IED or hand grenade) explodes in a room causing debris (stones, glass shards) to spread into the room or into the street, affecting other DOs. One or more walls initiate proximity engagements directed inwards and/or outwards.
- A grenade hits a vehicle and the personnel inside is affected by fragments of the grenade, fragments of the vehicle and/or the blast. The vehicle initiates a proximity engagement directed inside the vehicle. DOs outside the vehicle and in close proximity of the impact point might also be affected by a proximity engagement directed outwards from the side of impact. If the grenade does not penetrate the vehicle, DOs standing on the other side of the vehicle will not be affected.
- A grenade hits a vehicle, the vehicle explodes and DOs close to the explosion are affected by the debris of the vehicle and/or blast of the explosion. The vehicle initiates a proximity engagement in all directions.
- A grenade hits a fuel storage tank, the tank explodes and affects DOs near the storage tank. In this case the storage tank, modelled as a DO, initiates a proximity engagement.
- A grenade hits a CBRN storage tank, the tank is damaged and releases a CBRN cloud. The storage tank therefore creates a CBRN area.
- A vehicle enters a CBRN area and is contaminated. If the crew has not taken the proper protective measures, they will be contaminated by the vehicle.

Although not categorised as a propagation of engagements, an engagement can change the properties and engagements of a DO. Examples are:

- An explosive grenade destroys a room in a building. When subsequently other DOs enter the destroyed room, they get killed themselves.
- A vehicle is destroyed and is burning. When other DOs come too close to the burning vehicle or enter the vehicle, they can be affected.
- If a CBRN contaminated vehicle is not decontaminated, unprotected personnel interacting with the contaminated vehicle, can also be contaminated. In effect the contaminated vehicle becomes a small CBRN area.

Propagation of engagements can be intentional: such as when a shooter fires ammunition at a house in order to neutralise adversary personnel inside or unintentional (and thus classified as collateral damage) such as when an enemy armoured vehicle is destroyed and as a result civilians in the vicinity are wounded as a result of the explosion.

The objective of considering the example situations of propagation of engagements is to analyse if additional engagement mechanisms, parameters or ammunition codes are required. The conclusion is that the current identified engagement mechanisms and parameter sets are sufficient to implement propagation of engagements.

In order to implement the situation that a DO breaks apart and pieces of it engage other DO, a special ammunition code for “debris” must be present. It is not required to further subdivide this ammunition code, allowing for example to differentiate between size of debris or type of material. Such details go beyond the training objectives of UCATT, although it is recognised that small pieces of glass, large pieces of brick or hot pieces of metal can inflict different types of damage.

3.3.4.3 Equipment Pairing

This is defined as the situation where a piece of equipment that is not modelled as a DO, can be used by different DOs during an exercise, so it cannot, or at most only temporarily, be considered an integral part of a certain DO. The piece of equipment has no status of its own. Whether the equipment can be used or not is derived from the status of the DO that operates it. So for example a rifle can be passed from one soldier to another, but if the receiving soldier is heavily wounded, he cannot fire the rifle.

If it is determined to assign a status to the piece of equipment (is it operational or not?), then the equipment must be modelled as a DO and using the equipment by one or more DO is called DO association (described in the next section). For equipment pairing the equipment therefore must have a unique ID in the training system, but has no status of its own.

Typical example situations of equipment pairing are:

- The soldier’s personal weapon.
- A soldier takes a weapon from the rack of a vehicle.
- A soldier takes a weapon from a wounded comrade.
- A soldier puts on a CBRN mask.
- A soldier puts on a helmet.
- A soldier wears body armour.
- A soldier uses electronics, e.g., a laser target designator.

- A soldier uses a specific training device to perform specific interventions, like medical, repairing or resupply activities.
- A soldier throws a hand grenade (the grenade is not modelled as a DO). But for monitoring and AAR purposes it is desired to know who has thrown the grenade (e.g., to identify instances of friendly fire). That a thrown hand grenade can be picked up by another player and returned has not been considered a requirement.

It must be possible that one DO has multiple equipment pairings simultaneously, e.g., to wear a helmet and body armour at the same time. Also, it must be possible to distinguish between different types of the same kind of equipment, for example different types of body armour (to give different levels of protection), different types of CBRN protective measures, etc., and influencing damage calculations appropriately.

The purposes of equipment pairing are to:

- Register which DO uses what (type of) equipment. This can be used to influence the results of engagements (for example body armour increases protection against bullets) and for monitoring purposes.
- Check whether the operating DO is able (based on its damage state or functional qualifications or training) to use the equipment. A typical example of the latter case being the different levels of medical personnel where a Combat Life Saver is allowed to perform some basic medical treatments, while a doctor is allowed to perform more complex medical treatments. It is up to the training staff to decide how to tag the capabilities of each DO. For example, it can be set individually, or automatically derived from the function profile of the DO. Also the extent of this condition check remains a decision of the training staff. For example, it could be decided that an engineer is not allowed to fire an anti-tank weapon, because handling such a weapon is not part of his training as engineer. However, he could have acquired these skills in a previous function. Additionally, if an untrained operator manages to use the equipment effectively, even by sheer coincidence, the effect is valid, as it would be in reality.
- Check whether there is sufficient ammunition to fire the weapon. In the case the weapon in the training environment uses physical items (such as blanks) to enable the weapon to fire, the amount of these physical items will determine the number of times a functioning weapon can fire. However, if the training system does not use physical items to determine if the weapon can fire or not (but for example uses an ammo count residing in the DO), then the DO is responsible for disabling the weapon to fire when the ammo is exhausted.
- As stated, equipment pairing and also removing that pairing can change the properties of a DO and therefore can influence the results of engagement. For example, with body armour, a soldier is less vulnerable to a hit by a bullet than without body armour.
- Some engagements do not only occur at a specific instance in time, such as that delivered by a bullet, but last for a certain duration such as being exposed to a CBRN area. In these cases, removing the pairing between a piece of equipment and a DO will not only change the properties of that DO, but can also result in changing its damage status. For example, when standing in a CBRN area paired with a gas mask, a soldier might be protected and suffer no damage. When removing that gas mask (and pairing), his properties change and the soldier might become contaminated and even wounded or killed. Although no new engagement is initiated (the soldier did not move into a CBRN area, he is already in it), removing the equipment pairing along with his gas mask, changes the characteristics and the result of an ongoing engagement.

Requirements that result:

- Transfer the equipment ID to the operating DO (and from there to EXCON). This allows the training system to register who uses what equipment. Also the position of the equipment is derived from (and equal to) the position of the operating DO.

- Transfer the operating DO ID to the equipment. Required for training systems where the equipment physically implements an engagement, for example in laser based systems a rifle must transmit the shooter ID to the target.
- Preferably equipment pairing must occur without requiring special actions from the operator.
- For engagements the equipment pairing must take place in near real-time, because the pairing must be in effect when the equipment is actually used (e.g., firing a weapon, throwing a hand grenade) or the operating DO is engaged (e.g., a soldier is fired upon and does he wear body armour?).
- For monitoring purposes it is sufficient when the pairing is registered in administrative time (e.g., when was a CBRN mask put on?).

3.3.4.4 DO Association

DO association is defined as the situation where two or more DOs are logically grouped in order to, for example, synchronise their position or enable the propagation of effects, etc.:

- Synchronise the (simulated) position of the DOs in case DOs are physically connected to one another (e.g., persons mounted in vehicle or aboard a helicopter, persons in a building). In this situation the need for DO association originates from technical limitations, for example persons mounting a vehicle or entering a building can lose accuracy or even the complete track of the GPS or similar signal.
- Propagate effects in case DOs are enclosed within, on or adjacent to another DO (e.g., players mounted in a vehicle, in a building, a vehicle on a bridge, etc.). Propagation of effects is closely related to, but (technically) different from propagation of engagements. In case of propagation of engagements the engaged DO initiates another engagement and therefore can affect other DOs in its vicinity. That secondary engagement will initiate a damage calculation. Propagation of effects is setting the damage status of one of more DOs associated with the engaged DO. The damage calculation of the associated DO(s) is initiated by the primary engagement. Propagation of engagements and propagation of effects are different solutions/implementations to achieve a similar result.

  Propagation of effects occurs when a DO, associated with other DOs, is engaged and consequently the associated DOs can be affected. For example soldiers mount a vehicle, the vehicle is destroyed and consequently the soldiers are wounded or killed.

  DO association enables DOs to benefit or suffer from the associated infrastructure or vehicle. An example of suffering from an association is when a building is destroyed, soldiers within the building are wounded or killed. An example of benefitting from an association is when a vehicle is CBRN protected because of functioning ventilation/overpressure of the vehicle and the personnel within that vehicle does not need personal CBRN equipment to be protected against a CBRN engagement.

  Propagation of effects is also relevant for infrastructure objects that are composed of other objects, each modelled as a DO. For example a house can be made up of walls, floors, ceilings, doors and windows. When each of these elements is modelled as a DO, they can all have their own status. But there are dependencies based on the composition of the higher order object of infrastructure. For example, when a wall, containing a door, is destroyed, then also the door should be destroyed, even when the door itself is not engaged. When a house is made up of 4 walls and a ceiling, and 3 or more walls are destroyed, then also the supported ceiling should be destroyed, even when the ceiling itself is not engaged.
- Check whether the operating DO is able (based on its damage state) to use the operated equipment. For example, when the crew of a crew-served weapon is wounded, they will not be able to fire the weapon.

Typical example situations of DO association are:

- A soldier (DO) mounts an infantry fighting vehicle. When the vehicle moves, the position of the soldier is derived from the position of the vehicle.
- A soldier (DO) enters a building. When the building is damaged, consequently the soldier can get wounded or killed.
- A tank gunner (modelled as a DO) mounts a tank (another DO). When the vehicle is damaged, consequently the gunner can get wounded or killed. Conversely, when the gunner is wounded, consequently he cannot fire the gun of the tank.
- A vehicle enters a building. When the building is damaged, consequently the vehicle can sustain damage.
- A soldier or vehicle is on a bridge. When the bridge is destroyed, consequently the DOs on it can get killed.
- An anti-tank weapon (modelled as a DO) is operated by a soldier. When the soldier is wounded, consequently he cannot fire the anti-tank weapon.

Requirements that result:

- Transfer the IDs of the associated DOs amongst each other and to EXCON.

  For position synchronisation and propagation of effects this typically will be the transfer of the IDs of the smaller DOs to the larger DO (a vehicle or building must know which DOs it contains and a bridge must know which DO are on it, not the other way around). For checking the ability to employ equipment, this is the transfer of the operating DO ID to the employed DO.
- DO association must occur without requiring special actions from the involved DOs.
- For engagements the DO association must take place in near real-time.
- For monitoring purposes it is sufficient when the association is registered in administrative time.

A DO can have multiple associations at any given time. For example a DO can be in or on another DO, while being associated with one or more weapons. Association is assumed to be only one layer deep, although a DO can be in more than one DO simultaneously: a soldier can be in a vehicle while that vehicle is on a bridge but the soldier is associated only through the vehicle to the bridge.

3.3.5 E4 − DO Reporting

Reporting requirements can be separated into:

1) Requirements for exercise control (the process to monitor and control the content of an exercise to achieve the training or analysis objectives); and
2) System control (the process to monitor and control the state of the training system to enable an exercise).

3.3.5.1 Exercise Control

An important element of exercise control is monitoring events and (resulting) status changes of DOs. Typically the DOs causing and being affected by the event and the type of event must be reported in near real-time, while it should be possible to retrieve other associated parameters, such as weapon and ammunition used in a direct engagement. Also the data required to centrally determine the outcome of engagements are part of E4. The E4 dataset includes:

- Status changes of a DO (caused by the DO itself, events or by EXCON);

- Contact and proximity engagements;
- Missile engagements;
- Creation, deactivation and clearing of minefields;
- Minefield engagements;
- Activation of fire support target areas;
- Activation, changes and deactivation of CBRN areas;
- Activation and deactivation of decontamination areas;
- Energy weapons engagements;
- Jammer activation and deactivation;
- Repair activities;
- Medical engagements; and
- Logistic engagements.

Other types of data for exercise control are:

- Audio and video recorded for monitoring (especially Safety monitoring) and including used relevant radio channels and audio recorded from microphones installed at relevant locations must be made available in real-time.
- Audio and video images used for AAR purposes can be made available in administrative time.
- C4I data must be made available in near real-time.
- Weather data, such as information about temperature, light conditions, rain, fog, snow, etc., required for AAR purposes can be made available in administrative time.

3.3.5.2 System Control

A DO must report information regarding its administrative and technical status, to enable EXCON and system technicians to monitor the system status, perform maintenance, diagnose malfunctions etc. Typical data elements include:

- Technical status of the training equipment.
- Battery status.
- BIT (built in test).
- Radio signal strength (when applicable).
- Connectivity of system components (e.g., is the datalink operational?).
- Cheating signal (e.g., remove a cable).

The defined dataset for E4 contains all data elements that must be provided to enable all functions of exercise and system control. This dataset is described in Annex F.

Generally status changes of a DO are caused by external influences, such as an engagement from another DO (typically involving the E1 interface), being provided with the results of centrally adjudicated engagements (involving the E3 interface) or a direct (reset) action of an O/C (involving the E2 or E3 interface). For exercise control purposes it is important to know:

- Of which DO the status has changed.
- What the new status of that DO is.

- What the properties of the affected DO were at the moment of status change, such as location and speed.
- What the cause of the status change is.
- If applicable, which other DO has caused the status change.
- What the properties of that DO were at the moment of his engagement, such as location and speed.
- Not all information required for such an extensive report needs to be transmitted by the affected DO, but the training system can compose the report based on information from several resources. Obviously a DO can only report the information he is provided with or that he controls or computes himself. For example, in case of a direct engagement, the shooter DO will report (through E4) that he fires his main gun, while standing still at a certain location. When he hits another DO, the affected DO will report (also through E4) that he is engaged by the shooter DO, hit by a certain ammunition and as a result has suffered a mobility kill, while driving at a certain location. A typical situation for line-of-sight based training systems is depicted in Figure 3-1.

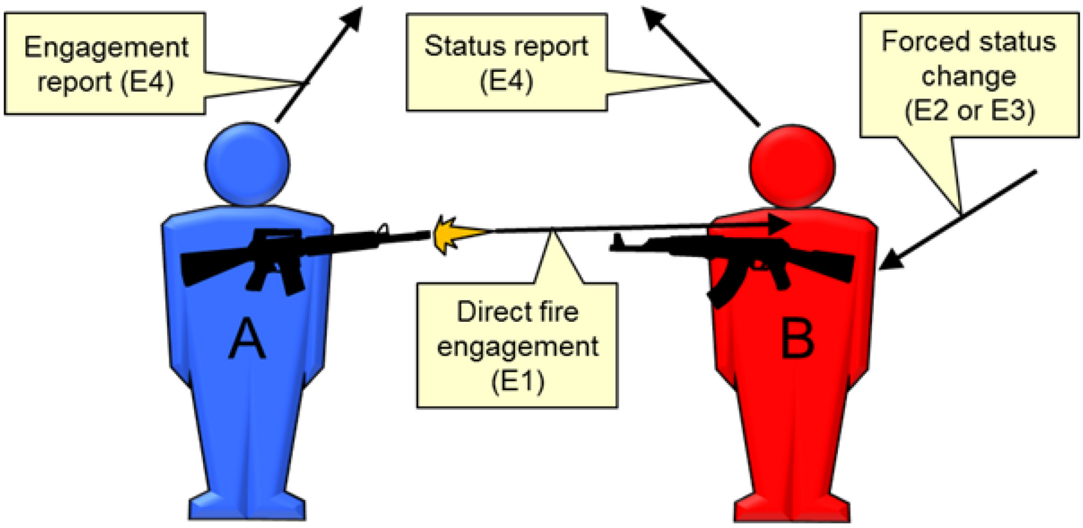

Figure 3-1: E4 Reporting for Line-of-Sight Training Systems.

DO A fires his rifle at DO B (E1 engagement), who as a consequence is killed.

DO A reports this direct engagement (E4 report), but does not know whether he hit DO B and what the consequence of the engagement is.

DO B senses the engagement and determines the outcome. Subsequently DO B reports he is engaged by DO A and the resulting status change (E4 report).

Similarly forced status changes by E2 and E3 are also reported by DO B.

A status change can also occur without an external cause, without the involvement of other DOs. Examples are an (automatic) tampering kill when the crew violates certain conditions or a health degradation over time when a wounded soldier is not treated.

3.3.6 E2 – Training System Status Change

This interface controls the technical status of a training system and its components. Through this interface it is possible that a DO is initialised, reset, calibrated, etc. This interface accommodates the distribution of an

(altered) terrain representation or damage models for systems that require such data at decentralised nodes. System management must be able to set or change the following data:

- Turning on or off of system components.
- Configuration of the system state.
- Mapping of players and equipment.
- Creating and modifying ORBATs.
- Loading reference data such as terrain database or damage model.

The corresponding dataset is described in Annex G.

3.3.7 E3 − DO Status Change

The E3 interface is used to set the (simulated) operational status of a DO, either as a direct action of an O/C or from EXCON, to distribute the outcome of an engagement that is centrally evaluated or to distribute characteristics of engagement areas and engagement parameters in order to determine engagements and/or outcomes of engagements at the DO level.

With direct interactions an O/C can control the status of a DO, by (re)setting the value of a particular variable. Generally this is done as an exercise intervention outside the tactical training exercise context. For example, to reset a DO either because of a malfunction of the training equipment or just to let him continue the fight for training purposes. If the affected DO is notified who caused the interaction, he will be notified it was an O/C or EXCON interaction.

For results of indirect fire more data can be required to provide to the affected DO than just the new status and cause (indirect fire). Information regarding for example type of ammunition, distance and direction with respect to the DO can be important to generate the appropriate messages or effects. Also the detonation location can result in different types of explosions, e.g., air burst versus ground explosions, which can be represented by different visual representations in the field, so the trainees can learn from it and take the proper measures.

The requirement to include full engagement data sets in E3 is justified to enable centrally triggered engagements be evaluated locally at the DO level.

The E3 dataset also contains information on the definition of engagement areas, such as minefields, fire support target areas and CBRN areas. The need for this requirement depends on the training system design. Three types of situations are considered:

- The engagement areas and DO interactions with these areas are only registered and managed by EXCON. EXCON determines the outcome of the engagement (damage calculation performed by EXCON) and only the results of an engagement are provided to the affected DO. In this case a DO does not need to know about (the definition of) engagement areas. Information about engagement areas is transferred between training systems through E8.
- EXCON determines an engagement of a DO with an engagement area and provides the DO only with the relevant data to determine the outcome of the engagement (damage calculation performed by a DO). For example, when a DO enters a minefield, the DO is provided with the type of mine he triggered, the DO is not provided with the properties of the whole minefield.
- The characteristics of engagement areas are provided to all DOs, so each DO can determine the interaction with an engagement area and subsequently, determine the outcome of that engagement (damage calculation performed by a DO).

In the latter two cases the information regarding interactions with engagement areas or regarding the characteristics of engagement areas respectively, is provided to DOs through E3.

The E3 dataset is defined in Annex H.

3.3.8 E5 − EXCON Communication

This interface enables the communication between training staff members of different systems operating in the same exercise, both analogue (typically voice) and digital communication.

For voice communication no dataset is required. Instead an agreement must be made on the frequency to be used. Generally there will be no requirement to encrypt the EXCON communication, but if so, an agreement must be made on the encryption method to be used. There are standards available to select from.

Of secondary priority are the following requirements:

- Audio recorded for monitoring and AAR purposes. This includes used relevant EXCON radio channels and audio recorded from microphones installed at relevant locations.
- Video images used for safety reasons must be made available in real-time, while video used for AAR purposes can be made available in administrative time.
- Digital data enabling remote EXCON functionality such as for example the current O/C laptop capability used in some systems.

3.3.9 E6 − Receive C4I Data and E7 − Send C4I Data

Since 1995 extensive studies have been conducted by NATO and the MIP (Multilateral Interoperability Programme) on how C4I systems should communicate with each other and exchange information between them. This has resulted in a model for data exchange, JC3IEDM, which has been accepted by many countries. For a live simulation system to read from and inject information into a C4I system it is recommended by UCATT that the JC3IEDM data model is used to define the information that is to be inserted or read from the C4I system.

C-BML might be useful in case of a synthetic wrap, when live DOs provide orders to simulated units.

It is recommended that liaison is established between the UCATT community and the NATO efforts enhancing the JC3IEDM and C-BML standards, in order to provide them with UCATT specific requirements.

3.3.10 E8 − Event Data Exchange

This interface enables the exchange of data between systems, which can influence the course of the training session and generally has a dynamic, time critical character. UCATT-2 recommended use of DIS or HLA as standard for this external interface. Insights gained during the UCATT-3 timeframe support this recommendation.

3.3.11 E9 − DO Association and Pairing

The E9 interface enables the logical linking of objects in the training environment, this includes linking of DOs amongst each other (DO association) and linking equipment that is not modelled as a DO with DOs (equipment pairing).

The dataset for DO association (and DO de-association) is a simple one, it contains the ID of the DO that is (dis)associated with a higher level or containing DO.

The dataset for equipment pairing is twofold. Transmitted from a piece of equipment to a DO:

- ID of the equipment.
- Type of equipment.

Transmitted from a DO to a piece of equipment:

- Signal to disable the equipment to function, based on conditions determined by the DO (e.g., its operational status, capability level or ammo count).

3.3.12 E10 − Exchange Platform Data

The E10 interface enables data exchange between the training system and instrumented operational (weapon) systems. It is recognised that the number of different types of operational systems that can be used in live training exercises is large and that each type of system probably will require a different dataset to be exchanged with a training system, depending on the functionality of both the operational system and the training system. Given the low priority of this interface in combination with the huge amount of work to investigate the system specific requirements, this interface was not researched in the UCATT-3 timeframe.

3.3.13 E11 − Reference Data Exchange

This interface enables the exchange of data that is generally used for reference purposes, such as ORBAT definitions, damage model definitions, geospatial (terrain) data, recorded exercises, etc.

MSDL seems to be a promising candidate as standard for (a large part of) E11. However, it has been observed that MSDL lacks some information on physical structures. Therefore it is recommended that the MSDL community should incorporate information on physical structures into the MSDL standard.

Annex A – TAP AND TOR UCATT LSS

A.1 TECHNICAL ACTIVITY PROPOSAL (TAP)

<table>
<tr><td>ACTIVITY REFERENCE NUMBER</td><td>MSG-140</td><td rowspan="2">ACTIVITY TITLE

URBAN COMBAT ADVANCED TRAINING TECHNOLOGY LIVESIM STANDARDS (UCATT LSS)</td><td>APPROVAL</td></tr>
<tr><td>TYPE AND SERIAL NUMBER</td><td>RTG</td><td>START
2015</td></tr>
<tr><td colspan="2">LOCATION(S) AND DATES</td><td>2015 Kickoff meeting Paris
2015 I-ITSEC meeting USA, Orlando

2016 ITEC/ spring meeting
2016 PDG/PSG autumn meeting
2016 I-ITSEC meeting USA, Orlando

2017 ITEC/ spring meeting
2017 PDG/PSG autumn meeting
2017 I-ITSEC meeting USA/Orlando

2018 ITEC/ spring meeting</td><td>END
2018</td></tr>
<tr><td colspan="2">COORDINATION WITH OTHER BODIES</td><td colspan="2">SISO</td></tr>
<tr><td colspan="2">NATO CLASSIFICATION OF ACTIVITY</td><td>RELEASABLE TO THE PUBLIC</td><td>Non-NATO Invited Yes</td></tr>
<tr><td colspan="2">PUBLICATION DATA</td><td>TR</td><td>UU</td></tr>
<tr><td>KEYWORDS</td><td colspan="3">URBAN COMBAT ADVANCED TRAINING TECHNOLOGY, UCATT, Live Simulation, Standards</td></tr>
</table>

A.1.1 Background and Justification (Relevance to NATO)

NATO Studies SAS 030, Study on Urban Operations 2020 and Land Operations 2020 clearly indicate that Urban Areas are the most likely battlefield in the 21st century.

The problems and limitations associated with developing the first generation of Military Operations on Urban Terrain (MOUT) training facilities are to be understood.

A team of experts from NATO NAAG completed a feasibility study in 2002 and concluded that a number of potential interoperability areas were identified and assessed to be worthy of further investigation.

MSG-032 UCATT (2003 – 2007) of NMSG started to identify and investigate some areas and reported them in their final report for the live domain. A number of areas were not completely covered or needed more investigation also a number of areas are new.

The UCATT report became more or less the guideline for URBAN COMBAT TRAINING facilities design.

Also the first steps in order to bring the defined interface specification to a standard (through the SISO) process had been started. MSG-063 UCATT-2 (2007 – 2011) the follow on of MSG-032 UCATT displayed the result of UCATT work approach in a life (technical) demonstration of interoperability between (modified) existing systems. A spin off of the UCATT work was a new laser standard (OSAG-2) that is already in use with a number of European countries. Goal of UCATT is that after SISO approval OSAG-2 is replaced by the laser implementation of the UCATT SISO standard.

Under the SISO organisation, a study group was formed (UCATT SG) to prepare the release of a product nomination for the UCATT standard framework.

MSG-063 was followed up by 2 new groups: MSG-098 (UCATT Architecture) and MSG-099 (UCATT Standards) (2011 – 2015).

They were tasked to refine the architecture (098) and writing the first SISO Standard (099). At the same time the SISO process was worked through by writing and getting approved the final SISO study group report.

A product nomination was submitted and approved. The PDG (Product Development Group) was established. The first release of the UCATT Standard with the laser implementation was submitted for balloting.

The virtual and constructive domain was explored and existing (SISO) standards were reviewed as a result of the UCATT architecture.

UCATT deliverables to date: Site register, Research needs, Interoperability specification, functional architecture, documented life interoperability demonstration, best practices, first release of SISO Standard (laser implementation), draft of player interface-implementation (E4).

In the last couple of years UCATT has become NATO's focal point for live training technologies. Beside that UCATT has become the focal point of information exchange for the military user community, government procurement and the leading Industries with respect to live training and simulation.

A.1.2 Objective(s)

Further development and support of the SISO UCATT standard. Transfer the currently used functional architecture into the NATO Architectural Framework (NAF) where applicable to verify the validity of the architectural approach in relation to physical implementations. Feedback as to the effectiveness of the physical implementation solutions will be given from the groups military experts with respect to the existing Use Cases. Identify, maintain and improve a suitable architecture and a standard set of interfaces that enable interoperability of live training and simulation components covering the urban aspects that does not inhibit future research and enhancements.

Validate the applicability of existing standards for interfacing to the simulation environment. Further develop the SISO UCATT standard (PDG) in accordance with the Product Nomination (PN) and maintain the Standard as a Product Support Group (PSG).

Maintain function as focal point for live training and simulation technologies and standards.

A.1.3 Topics to be Covered

Operational Concepts: continuous maintenance of the comprehensive list of developed Generic User Requirements in conjunction with NATO Training Groups and Military Users on the live, virtual and the constructive domain.

Further standardisation through the SISO process of UCATT defined and prioritised interfaces following the functional architecture. Maintain the UCATT functional architecture for live training and simulation.

Establishment of a PSG to maintain the UCATT Standards.

A.1.4 Deliverables (e.g., Model, Database, …) and/or End Products

- Technical Report.
- SISO Standard(s).

A.1.5 Technical Team Leader and Lead Nation

Lead Nation: Germany.

Points of Contact: Chair: Mr. Armin THINNES, Germany (arminthinnes@bundeswehr.org, +49 261 400 5234)
Deputy Chair: Mr. Ingo WITTWER, Germany (ingo.wittwer@ruag.com, +49 4103 939 580)

A.1.6 Nations Willing/Invited to Participate

NATO Nations and Bodies: All NATO Nations and Bodies invited.

PfP Nations: All PfP nations invited.

Industries: All relevant industries are invited.

Global Partners: Australia, Japan, South Korea and New Zealand invited.

The following Nations willing to participate: Germany, Great Britain, Netherlands, France, Sweden, United States of America, Austria and Switzerland.

The following Industries are willing to participate: Cubic Defence systems (USA/NZL), SAAB AB (SWE), Thales Training and simulation (FRA), Airbus Group (FRA), GDI Simulation (FRA), RUAG (DEU/CHE) and Rheinmetall Defence (DEU).

A.1.7 National and/or NATO Resources Needed (Physical and Non-Physical Assets)

Personnel resources (technical/scientific and military) are to be provided through national contributions.

Travel costs are to be provided through national contributions.

SISO membership fees for NATO and PfP representatives, support for meeting-facilities and PR-material if applicable.

A.1.8 CSO Resources Needed (e.g., Consultant Funding)

Standard support for STO Task Groups in accordance with the current edition of the STO Operating Procedures.

A.2 TERMS OF REFERENCE

A.2.1 Origin

A.2.1.1 Background

NATO Studies SAS 030, Study on Urban Operations 2020 and Land Operations 2020 clearly indicate that Urban Areas are the most likely battlefield in the 21st century.

The problems and limitations associated with developing the first generation of Military Operations on Urban Terrain (MOUT) training facilities are to be understood.

A team of experts from NATO NAAG completed a feasibility study in 2002 and concluded that a number of potential interoperability areas were identified and assessed to be worthy of further investigation.

MSG-032 UCATT (2003 – 2007) of NMSG started to identify and investigate some areas and reported them in their final report for the live domain. A number of areas were not completely covered or needed more investigation also a number of areas are new.

The UCATT report became more or less the guideline for URBAN COMBAT TRAINING facilities design.

Also the first steps in order to bring the defined interface specification to a standard (through the SISO) process had been started. MSG-063 UCATT-2 (2007 – 2011) the follow on of MSG-032 UCATT displayed the result of UCATT work approach in a life (technical) demonstration of interoperability between (modified) existing systems. A spin off of the UCATT work was a new laser standard (OSAG-2) that is already in use with a number of European countries. Goal of UCATT is that after SISO approval OSAG-2 is replaced by the laser implementation of the UCATT SISO standard.

Under the SISO organisation, a study group was formed (UCATT SG) to prepare the release of a product nomination for the UCATT standard framework.

MSG-063 was followed up by 2 new groups: MSG-098 (UCATT Architecture) and MSG-099 (UCATT Standards) (2011 – 2015).

They were tasked to refine the architecture (098) and writing the first SISO Standard (099). At the same time the SISO process was worked through by writing and getting approved the final SISO study group report.

A product nomination was submitted and approved. The PDG (Product Development Group) was established. The first release of the UCATT Standard with the laser implementation was submitted for balloting.

The virtual and constructive domain was explored and existing (SISO) standards were reviewed as a result of the UCATT architecture.

UCATT deliverables to date: Site register, Research needs, Interoperability specification, functional architecture, documented life interoperability demonstration, best practices, first release of SISO Standard (laser implementation, draft of player interface-implementation (E4).

In the last couple of years UCATT has become NATO’s focal point for live training technologies. Beside that UCATT has become the focal point of information exchange for the military user community, government procurement and the leading Industries with respect to live training and simulation.

A.2.1.2 Justification (Relevance for NATO)

- Maintenance of comprehensive list of Generic Harmonised (between Nations) User Requirements in conjunction with NATO Training Groups and Military Users on the live, virtual and the constructive domain.
- SISO standardised LIVE simulation and training interoperability interfaces to cope with the defined Use Cases enabling international interoperable training.
- Extension of the live functional architecture for LIVE training according to new Use Cases.

A.2.2 Objectives

Further development and support of the SISO UCATT-standard. Transfer the currently used functional architecture into the NATO Architectural framework (NAF) where applicable to verify the validity of the architectural approach in relation to physical implementations. Feedback as to the effectiveness of the physical implementation solutions will be given from the groups military experts with respect to the existing Use Cases. Identify, maintain and improve a suitable architecture and a standard set of interfaces that enable interoperability of LIVE training and simulation components covering the urban aspects that does not inhibit future research and enhancements.

Validate the applicability of existing standards for interfacing to the simulation environment. Further develop the SISO UCATT standard (PDG) in accordance with the Product Nomination (PN) and maintain the Standard as a Product Support Group (PSG).

Maintain function as focal point for live training and simulation technologies and standards.

A.2.3 Resources

A.2.3.1 Membership

Members should be specialists in the field of live simulation and training from the contributing NATO nations and other NMSG's associated members.

Three face-to-face meetings per year are planned. Between the personal meetings work is planned to be carried out using Internet. Appropriate collaboration mechanisms will be used as support tools (Mailing-Lists, Website, Sharepoint, etc.).

Lead Nation: Germany.

Points of Contact: Mr. Armin THINNES (arminthinnes@bundeswehr.org)
Mr. Ingo WITTWER (ingo.wittwer@ruag.com)

Nations willing/invited to participate:

- Willing: Germany, Netherlands, United Kingdom, United States, France, Sweden, Switzerland, and Austria.
- Invited: All NATO and PfP Nations, Global Partners.

Industries willing/invited to participate:

- Cubic Defence systems (USA/NZL), SAAB AB (SWE), Thales Training and simulation (FRA), Airbus Group (FRA), GDI Simulation (FRA), RUAG (DEU/CHE) and Rheinmetall Defence (DEU).
- Invited: All relevant simulation industries.

A.2.3.2 National and/or NATO Resources Needed

- Personnel resources (technical/scientific and military) are to be provided through national contributions.
- Travel costs are to be provided through national contributions.
- SISO membership fees for NATO and PfP representatives, support for meeting-facilities and PR-material, if applicable.

A.2.3.3 CSO Resources Needed

- Standard support for STO Task Groups in accordance with the current edition of the STO Operating Procedures.

A.2.4 Security Classification Level

The activity and the deliverables are classified as "RELEASABLE TO THE PUBLIC" (UU).

A.2.5 Participation by Partner Nations

PfP Nations:	All PfP nations invited.
Global Partners:	Australia, Japan, South Korea and New Zealand invited.

A.2.6 Liaison

- SISO (coordination with UCATT PDG standardisation activities).

Annex B – EXERCISE NOBLE LEDGER

To investigate the interoperability aspects of this exercise, the UCATT functional architecture is taken as reference to describe to what extent the different systems were able to exchange data and through which interfaces.

B.1 E1 – LASER ENGAGEMENT

In regard to the laser interface for engagements all systems were already interoperable on the physical level, using the same laser properties (class, power, wavelength, etc.). Therefore this interface was used successfully. For laser coding, the picture was as follows:

- NACMTC used OSAG 2.0 Standard.
- MCTC can use both OSAG 2.0 Standard and Basic.
- DNK vehicle equipment uses OSAG 2.0 Basic.
- DEU AGDUS uses OSAG 2.0 Basic.

This meant that OSAG 2.0 Basic was the lowest common denominator and most logical choice for this interface. NACMTC did not support OSAG 2.0 Basic, but was given the ability to switch between Basic and Standard like MCTC. Finally, the standard ammunition tables belonging to OSAG 2 were used to achieve full interoperability.

B.2 E2 – CONTROL SYSTEM STATUS AND E4 – REPORT STATUS

The E2 and E4 interfaces rely on the long-range radio (LRR) infrastructure network. That means that the host system, in this case NACMTC, dictates how that infrastructure looks like. NACMTC uses the Saab proprietary DAN network, revision 5, and the PDU 2.1C Long Range Radio Data Protocol. Coincidently, MCTC and DNK used the same, which provided interoperability, so these interfaces were used successfully.

For the NOBLE LEDGER exercise, the coverage NACMTC could provide with its mostly static and single portable base station was not enough for a Brigade level exercise. To enlarge the coverage area, MCTC provided 6 additional portable base stations and Saab Sweden provided an additional two. Germany brought non-instrumented AGDUS for this exercise, which meant their equipment had no radio to connect to any infrastructure. As a work-around for this challenge, MCTC vests were strapped onto German combat vehicles to serve as a blue-force tracker. This ensured EXCON could have a complete operational picture as far as units and vehicles were concerned. German dismounted troops were not visible, which meant they had to be umpired during battle by O/Cs.

B.3 E3 – CONTROL DO STATUS

The E3 interface relies on the same long-range radio infrastructure network as E2 and E4. As mentioned above, the ability to exchange data between EXCON and players was already achieved there. The E3 interface however, is mainly used to transfer artillery, CBRN and Engineering effects like minefields. This means the radio commands triggering those types of engagements would have to be standardised. NACMTC, MCTC and the Danish vehicle equipment all used the IUC released AWES 2.0 Basic simulation guideline to ensure interoperability.

B.4 E5 − EXCON COMMS

This interface is more commonly referred to as the O/C voice network, even though it is also used for data transmissions between EXCON and the O/Cs in the field and between O/Cs directly. The O/C voice network uses standard analogue FM radio technology, where every different system has its own fixed frequency range. Unfortunately none of these ranges overlapped, which meant there was no communication possible between O/Cs from different nationalities. A big factor here, determining native frequency ranges, is national frequency management regulations.

B.5 E6 − C4I TO EXCON AND E7 − EXCON TO C4I

Out of this composition of systems, only MCTC possesses the ability to exchange data with C4I systems like BMS (Battlefield Management System), and only in the direction of EXCON (E6). This interface is used to log BMS data to be used for AAR purposes. C4I systems are a very scattered field today and most countries, mostly for reasons of operational security, choose to build their own software and architectures. Even though standards like JC3IEDM exist, interoperability between C4I systems is still fairly difficult to achieve. Therefore, BMS systems are not often used during multinational exercises, as not all information can reach all participating units. This was the case for NOBLE LEDGER as well and therefore this interface was disregarded.

B.6 E8 − EXCON TO EXTERNAL SYSTEMS

This interface was not necessary to be used for this exercise, as it is used to connect for instance MCTC and GÜZ Altmark (see Section 1.3.1).

B.7 E9 − REPORT STATUS TO SENSE

This interface allows the soldier to pair with his weapon, a building or vehicle and works through Short Range Radio (SRR). In a multinational interoperability sense, it should allow a soldier using a vest from system A to pair with and use a weapon instrumented by system B. Even though this interface was not tested during NOBLE LEDGER, it is very likely interoperability could have been achieved here among at least the Dutch, Norwegian and Danish troops. These systems all use the Saab proprietary, IUC published, WLN protocol.

B.8 E10 − PLATFORM MANAGEMENT

The usage of this interface implies the instrumentation of a combat vehicle from country A (e.g., CV90 or Marder) with instrumentation from a system owned by country B. This was not foreseen and did not take place during NOBLE LEDGER and it would have been very unlikely to succeed. The interfaces between real-life vehicles and live simulation systems are custom built, in close cooperation with the vehicles manufacturer. A big factor standing in the way of interoperability here is both operational and commercial security and a 3rd party will not quickly get access to a vehicles' internal network.

B.9 E11 − MANAGE DATA TO STORE DATA

The E11 interface can be used for a lot of different types of initialisation data, but is most commonly used for ORBAT data. This data is needed to associate equipment with persons, units and vehicles, which in the end allows for a logical picture of events during AAR. For the Saab systems involved during NOBLE LEDGER they are natively fed into the system in the same way. The German AGDUS is excluded here, since it does

not communicate with any EXCON. The ORBAT is normally created in an Excel file and after conversion to .XML transferred to the system through a simple USB drive. The only thing needed to standardise input is to create an Excel template that all countries use, which is exactly what was done for NOBLE LEDGER to avoid manual input. Therefore this interface was considered used successfully.

Table B-1: Summary of Results.

Interface	Result
E1 – Laser engagement	SUCCESSFUL
E2 – Control system status	SUCCESSFUL
E3 – Control DO status	SUCCESSFUL
E4 – Report status	SUCCESSFUL
E5 – EXCON Comms	UNSUCCESSFUL
E6 – C4I to EXCON and E7 – EXCON to C4I	NOT USED
E8 – EXCON to External systems	NOT USED
E9 – Report Status to Sense	NOT USED, PLAUSIBLE COMPATIBILITY
E10 – Platform management	NOT USED, HIGHLY UNLIKELY
E11 – Manage data to Store data	SUCCESSFUL

Annex C – CALCULATION OF THE NUMBER OF PLAYER IDs

This annex contains the calculations that are the basis for considering the maximum number of DOs (player IDs) for use in Live Simulation Systems. They are not to be considered definitive or exact, partly because different nations have different composition of forces. However, the assumption is made, that even though compositions differ, the order of magnitude are similar. The calculations are based on the unit type regarded to have the most number of entities: the Mechanised (Infantry) Unit. The numbers stated in the tables below per category are an indication, not a constraint for that particular category.

Table C-1: Maximum DO Numbers Calculation.

• **Armoured Infantry Group**

Unit	Personnel	Weapon Platforms	Personal/Group Weapons	Other
Group	10	1	30	20
Cumulative	0			
	DOs per level	**61**		

••• **Armoured Infantry Platoon**

Unit	Personnel	Weapon Platforms	Personal/Group Weapons	Other
Cumulative (4 inf gps)	244			
	DOs per level	**244**		

I **Armoured Infantry Company**

Unit	Personnel	Weapon Platforms	Personal/Group Weapons	Other
Coy staff	15	5	50	20
Mortar gp	10	3	20	20
Transport level -1 (4 inf platoons)	976			
	DOs per level	**1,119**		

II **Armoured Infantry Battalion**

Unit	Personnel	Weapon Platforms	Personal/Group Weapons	Other
Battalion staff	40	20	80	40
Recce platoon	40	8	120	80
AT platoon	18	6	36	40
Transport lvl -1 (3 inf coy's)	3,357			
	DOs per level	**3,885**		

II Tank Battalion

Unit	Personnel	Weapon Platforms	Personal/Group Weapons	Other
Battalion staff	40	20	80	40
Tank squadron (x3)	210	50	420	420
	DOs per level	**1,280**		

X Mechanised Brigade and Added Enablers

Unit	Personnel	Weapon Platforms	Personal/Group Weapons	Other
Brigade staff	150	30	300	300
Engineer Construction Battalion	550	100	1,500	1,000
Armoured Engineer Battalion	550	100	1,500	1,000
Artillery Battery	200	8	400	400
Air Defence Artillery	450	50	900	200
Logistic Support Det (LSD)	900	100	1,830	400
Transport lvl -1 (2 Inf Battalions)	7,770			
Transport lvl -1 (2 Tk Battalion)	2,560			
	DOs per level	**24,908**		

~ Other Units and Entities

Unit		
Civilian population		1,000
Infrastructure (structures, bridges)		5,000
Minefields (individual mines)		10,000
Fire support units (navy, air force)		1,000
UAS/UGS		1,000
Other (sensors)		1,000
Recce squadron		6,000
	DOs per level	**25,000**

Total number of DOs for one Mechanised Brigade, incl. instrumented infrastructure	**49,908**
Total number of unique identifying numbers, based on a Bde on Bde exercise	**100,000**

Annex D – DO STATUS DEFINITION

One of the defining properties of a DO is that it has a status and that that status can change (generally as a result of engagements). The most simple set of statuses consists of "dead" and "alive". It is recognised that some systems have a more elaborate or detailed set of statuses for DO than other systems, most likely because there are specific engagements related to those statuses. For example, when enabling several types of medical treatment engagements, the set of statuses must be more advanced than only "dead" or "alive" to be useful.

Although from a technical point of view it is not required that training systems use the same DO statuses, interoperability among training systems is facilitated when the used DO statuses are comparable and standardised. To accommodate this standardisation, UCATT describes several levels of DO statuses. The logical starting point to define sets of DO statuses would be the commonly used statuses in current training systems. Such a list would look like the one presented in Table D-1.

Table D-1: Overview of Commonly Used DO Statuses.

DO Status	Description
Operational	The DO can use all its capabilities
Hit, no damage/effect	The DO was engaged and hit, but no loss of capability was assessed
Miss	The DO was engaged, but not hit
Mobility Kill	The DO cannot change its location by itself
Weapon Kill	The DO cannot use its weapon(s)
Communications Kill	The DO cannot use its communication equipment
Sight/sensor Kill	The DO cannot use its sensors
Payload Kill	The cargo of the DO is destroyed
Total Kill	The DO cannot use any of its capabilities
Tampering Kill	The DO cannot use any of its capabilities. Assigned by the system when the trainee(s) violate(s) certain conditions
Administrative Kill	The DO cannot use any of its capabilities. Assigned by an O/C or through EXCON

This set of DO statuses is imbalanced because it contains three types of information:

1) The (loss of) capabilities of the DO. This category of information consists of "Operational", "Weapon Kill", "Communications Kill", "Sight/sensor Kill", "Payload Kill" and "Total Kill".

2) Information about engagements on the DO that did not result in a DO status change. These are "Hit, no damage/effect" and "Miss".

3) The reason or cause of a DO status change. These are "Tampering Kill" and "Administrative Kill", where it is assumed that the "Total Kill" is the result of a proper engagement in the training context.

UCATT considers only the first type of information, concerning the capabilities of a DO, relevant to be reflected in the DO status.

There is no need for "Hit, no damage/effect" and "Miss" as DO status. In terms of DO capabilities they are the same as "Operational". The training system must still be able to register all engagements and their results, also when the engagement was not effective, but other mechanisms must be used to register and retrieve that information (call it "engagement status"). So EXCON must still be able to see that a shooter (nearly) missed a target. And for example a vehicle being hit, but not damaged, should still be able to generate an audio cue for its crew to notify them they are under fire.

There is no need to reflect in the DO status the reason or cause of that change, so there is no need for "Tampering Kill" and "Administrative Kill". In terms of DO status they are the same as "Total Kill". However, the training system must still be able to register the cause of a DO status change, but other mechanisms must be used to register and retrieve that information. It is recognised that interference by an O/C is a special cause, but there are also not special statuses for "Killed by a direct hit" or "Killed by a mine".

At a lower level of damage statuses there is found a fourth type of information: one that deals with controlling the visual representation of a specific damage. Examples of these statuses are "Mobility kill visual" and "Weapon kill visual" in order to display certain signals in the training environment, indicating a DO has lost its ability to move or fire, respectively. It is not denied that there should be no difference between a (visually) undetectable mobility kill and a visible mobility kill, but the damage status is not the proper mechanism to specify this.

A "Tampering kill" is assigned to a DO when the training system detects that a trainee violates certain exercise rules that can be classified as cheating. A typical example is taking out the batteries of his instrumentation kit so he will be invulnerable. There might be other conditions that can also be considered as cheating, but one has to be careful for exceptions. For example, moving while having sustained a mobility kill can be considered as cheating. But for safety (non-exercise related) reasons it might sometimes be necessary to step out of harm's way. Or what if a vehicle is towed away for repair?

The DO statuses are categorised in levels (see later). In addition, DO statuses are defined for three types of DO, namely:

1) Vehicles (in the broadest sense, it includes weapon systems, aircraft and naval vessels);
2) Personnel; and
3) Infrastructure.

This distinction is relevant because different status terminology is used for these types of DO, even though the effect is similar (for example, a vehicle is damaged, while a person is wounded). Technically speaking a person can have a mobility kill, fire power kill etc., but UCATT has respected the historically adopted terminology of categories of "wounded" (these categories can be mapped onto the capabilities of a soldier which are comparable to those of vehicles). Despite the differences in terminology, the logic behind the levels and categories are the same: there are three main statuses (fully operational, degraded performance, fully disabled) and each level is a further detailing of the previous level. At the first and second level the statuses each imply a different loss of capabilities of the DO. At the third level and below no different types of capability loss are defined, but the statuses contain a more detailed specification of a certain type of capability loss, mainly used to enable repair or medical activities. For example, the third level vehicle statuses "Track/wheel fallen off" and "Engine kill" both inhibit a vehicle to move and are two different instances of the second level "Mobility kill".

A DO can also have multiple statuses, except for "Operational" (any other status overrules this status) and "Total kill" (this status overrules all other statuses).

Two remarks must be made regarding the status of a crewed vehicle modelled as a DO.

First, a crewed vehicle is in fact a combination of several DOs, namely the vehicle and each of its crew. Consequently, the vehicle and each crewmember will have their own status. All combinations of statuses are possible, but two extremities will be commented on. It is possible that the vehicle is destroyed (total kill), while all its crew members are still alive and operational. This can for example be the case when the vehicle is struck by an EMP, destroying the vehicle's electronic systems but not harming the crew or when the crew were not in the vehicle when it was destroyed. The reverse is also possible, that all crewmembers are killed, but the vehicle has sustained no damage. This can for example be the case when the vehicle enters a CBRN area and the crew has not taken the proper protective measures. This will kill the crew, but will not damage the vehicle. Because the crew is dead, the vehicle capabilities are of no use. Some would argue therefore that the vehicle should have a total kill as well, but this would be incorrect. For in theory a new crew with protective clothing can use the vehicle and operate it in its current state (which therefore must be operational). Using this logic, there is no need for a status "CBRN kill" as can be encountered in some systems. A CBRN attack can result in a contamination of the vehicle and disabling or killing the crew.

A second remark addresses the fact that in some implementations of training systems the crew or other occupants of a vehicle are not modelled as DOs. They are considered as an integral part of the vehicle and therefore there is only one DO (the vehicle). This does not reflect reality perfectly, but cost considerations will have played a major role in this decision. To be able to model the situation were the crew and vehicle can have distinct statuses (as described above, such as relevant for CBRN engagements), separate statuses must be defined. For example a status "Crew killed" or at a more detailed level "Commander killed". For crewmembers not modelled as DOs it is not useful to assign them statuses regarding the severity, type or location of wounds because they because they cannot be treated like personnel that is modelled as DO.

For detailed medical diagnosis and treatment of personnel the training system could simulate data like (simulated) heartbeat, blood pressure, consciousness etc. Although from a medical point of view this data (call it symptoms?) would be seen as part of the status of the wounded DO, this type of data has no tactical relevance and therefore will not be reflected in the DO status. On a practical note is apparent that the number of statuses would be very high! As a note it is observed that in some current training systems this data about symptoms is simulated by the medical DO instead of the wounded DO.

D.1 DAMAGE STATUS CATEGORIES

Damage statuses are defined for three different categories of DO. For each category of DO, different levels of interoperability are defined, where each subsequent level can contain more detailed status information.

Table D-2 lists the damage statuses of (crewed) weapon systems and contains 4 levels of interoperability:

- Level 1 concerns the primary functions of entities: move, engage, communicate, observe and perform logistics.
- Level 2 concerns useful secondary functions of entities.
- Level 3 concerns maintenance and repair activities.
- Level 4 concerns details regarding C4ISR systems.

Table D-3 lists the damage statuses of personnel and contains 3 levels of interoperability.

- Level 1 concerns the primary functions of an individual (move, communicate, engage).
- Level 2 differentiates between injured body parts, resulting in the (dis)ability to use them.
- Level 3 concerns more advanced injury information for medical treatment.

Table D-4 lists the damage statuses of infrastructural objects and contains 2 levels of interoperability:

- Level 1 provides the primary function of infrastructure to the training audience (e.g., a wall provides cover and/or protection, a bridge can enable personnel and vehicles to cross a gap).
- Level 2 provides degraded functions of infrastructure to the training audience.

Table D-2: Damage Statuses of (Manned) Weapon Systems.

Damage State	Level 1	Level 2	Level 3	Level 4	Description
Operational	0	0	0	0	
CBRNe crew Kill		0.1	0.1.0	0.1.0.0	Crew killed, but vehicle is operational, can be recovered by a new crew
CBRNe contaminated		0.2	0.2.0	0.2.0.0	Vehicle is contaminated, but still operational, can be recovered by decontamination
Hit, no damage/effect	1	1.0	1.0.0	1.0.0.0	Target was engaged and hit, but no damage was assessed
Miss	2	2.0	2.0.0	2.0.0.0	Target was engaged but not hit (could result in an audio cue for the crew)
Near miss		2.1	2.1.0	2.1.0.0	
Far miss		2.2	2.2.0	2.2.0.0	
Mobility kill	3	3.0	3.0.0	3.0.0.0	Target cannot move location
Engine kill			3.0.1	3.0.1.0	
Track/wheel fallen off/kill			3.0.2	3.0.2.0	
Mobility kill visual		3.1	3.1.0	3.1.0.0	Observable mobility kill
Weapon kill	4	4.0	4.0.0	4.0.0.0	All weapons inoperative
Main gun kill		4.1	4.1.0	4.1.0.0	
Weapon <x> kill			4.1.<x>	4.1.<x>	Kill of a specific weapon system of the vehicle (can be up to 100)
Secondary weapon kill		4.2	4.2.0	4.2.0.0	Definition of what the secondary weapon is, depends on the type of vehicle
Missile weapon kill		4.3	4.3.0	4.3.0.0	Valid when the vehicle has a missile firing system
Turret drive kill		4.4	4.4.0	4.4.0.0	The turret of the vehicle cannot rotate

Damage State	Level 1	Level 2	Level 3	Level 4	Description
Ammunition kill		4.5	4.5.0	4.5.0.0	
Automatic ammo load off			4.5.1	4.5.1.0	
Ammo turret storage kill			4.5.2	4.5.2.0	
Ammo hull storage kill			4.5.3	4.5.3.0	
LRF kill		4.6	4.6.0	4.6.0.0	
Weapon kill visual		4.7	4.7.0	4.7.0.0	Observable that all weapons are inoperative
C4ISR kill	5	5.0	5.0.0	5.0.0.0	C4I functionality not available
Communications kill		5.1	5.1.0	5.1.0.0	Loss of (voice and data) communication
Voice comms damage/kill			5.1.1	5.1.1.0	
Voice comms kill				5.1.1.1	
Voice comms degraded				5.1.1.2	
Data comms damage/kill			5.1.2	5.1.2.0	
Data comms kill				5.1.2.1	
Data comms degraded				5.1.2.2	
Data comms corrupted				5.1.2.3	
BMS computer kill		5.2	5.2.0	5.2.0.0	
Sight/sensor kill		5.3	5.3.0	5.3.0.0	Contains all different kind of sensors, optical, radar etc. that enable it to perform its primary function
Primary sight kill			5.3.1	5.3.1.0	
Secondary sight kill			5.3.2	5.3.2.0	
Auxiliary sight kill			5.3.3	5.3.3.0	
IFF kill			5.3.4	5.3.4.0	
Payload kill	6	6.0	6.0.0	6.0.0.0	Destruction of the cargo of the vehicle
Total kill	7	7.0	7.0.0	7.0.0.0	Catastrophic kill
Crew affected		7.1	7.1.0	7.1.0.0	Relevant for occupants not being DOs (DOs have their own status)
Crew member <x> killed			7.1.<x>	7.1.<x>	Relevant for occupants not being DOs
Crew member <x> injured			7.2.<x>	7.2.<x>	Relevant for occupants not being DOs

Damage State	Level 1	Level 2	Level 3	Level 4	Description
Tampering kill	8	8.0	8.0.0	8.0.0.0	Automatic kill when the crew violates certain conditions
Administrative kill	9	9.0	9.0.0	9.0.0.0	Killed by an OC or through EXCON administrative kill

Table D-3: Damage Statuses of Personnel.

Damage State	Level 1	Level 2	Level 3	Move	Fire	Communicate
Operational	0	0	0	YES	YES	YES
CBRNe contaminated		0.1	0.1.0	YES	YES	YES
Hit No Damage/effect	1	1.0	1.0.0	YES	YES	YES
Incapacitated/stunned		1.1	1.1.0	NO	NO	NO
Miss	2	2.0	2.0.0	YES	YES	YES
Far Miss		2.1	2.1.0	YES	YES	YES
Near Miss		2.2	2.2.0	YES	YES	YES
Wounded	3	3.0	3.0.0	NO	NO	YES
Head		3.1	3.1.0	NO	NO	NO
Bleeding			3.1.1	NO	NO	NO
Blast			3.1.2	NO	NO	NO
Burn			3.1.3	NO	NO	NO
Chest		3.2	3.2.0	NO	NO	NO
Bleeding			3.2.1	NO	NO	NO
Blast			3.2.2	NO	NO	NO
Burn			3.2.3	NO	NO	NO
Torso		3.3	3.3.0	NO	NO	NO
Bleeding			3.3.1	NO	NO	NO
Blast			3.3.2	NO	NO	NO
Burn			3.3.3	NO	NO	NO
Stomach		3.4	3.4.0	NO	NO	NO
Bleeding			3.4.1	NO	NO	NO
Blast			3.4.2	NO	NO	NO
Burn			3.4.3	NO	NO	NO

Damage State	Level 1	Level 2	Level 3	Move	Fire	Communicate
Left arm		3.5	3.5.0	YES	NO	YES
Bleeding			3.5.1	YES	NO	YES
Blast			3.5.2	YES	NO	YES
Burn			3.5.3	YES	NO	YES
Broken			3.5.4	YES	NO	YES
Right arm		3.6	3.6.0	YES	NO	YES
Bleeding			3.6.1	YES	NO	YES
Blast			3.6.2	YES	NO	YES
Burn			3.6.3	YES	NO	YES
Broken			3.6.4	YES	NO	YES
Left leg		3.7	3.7.0	NO	YES	YES
Bleeding			3.7.1	NO	YES	YES
Blast			3.7.2	NO	YES	YES
Burn			3.7.3	NO	YES	YES
Broken			3.7.4	NO	YES	YES
Right leg		3.8	3.8.0	NO	YES	YES
Bleeding			3.8.1	NO	YES	YES
Blast			3.8.2	NO	YES	YES
Burn			3.8.3	NO	YES	YES
Broken			3.8.4	NO	YES	YES
C4ISR kill	4	4.0	4.0.0	YES	YES	NO
Communications Kill		4.1	4.1.0	YES	YES	NO
Voice comms damage/kill			4.1.1	YES	YES	NO
Voice comms kill				YES	YES	NO
Voice comms degraded				YES	YES	NO
Data comms damage/kill			4.1.2	YES	YES	NO
Data comms kill				YES	YES	NO
Data comms degraded				YES	YES	NO
Data comms corrupted				YES	YES	NO
BMS computer kill		4.2	4.2.0	YES	YES	NO
Sensor kill		4.3	4.3.0	YES	YES	NO

Damage State	Level 1	Level 2	Level 3	Move	Fire	Communicate
Kill	5	5.0	5.0.0	NO	NO	NO
Administrative kill	6	6.0	6.0.0	NO	NO	NO
Tampering kill	7	7.0	7.0.0	NO	NO	NO

Table D-4: Damage Statuses of Infrastructural Objects.

Damage State	Level 1	Level 2	Description
Undamaged	0	0	
Door/window open		0.1	
Door/window closed, not bolted		0.2	
Door/window closed, simulated bolted		0.3	
Door/window bolted and barred		0.4	
Hit, no damage/effect	1	1.0	Structure was engaged (could result in an audio cue for the occupants of the structure)
Miss	2	2.0	Structure was engaged but not hit (could result in an audio cue for the occupants of the structure)
Near Miss		2.1	
Far Miss		2.2	
Damaged	3	3.0	
Destroyed	4	4.0	
CBRNe Kill			For example, a structure could protect against fluids, but not against gasses
Payload Kill	5	5.0	Destruction of the content of a structure, e.g., supplies
Tampering Kill	6	6.0	Automatical destruction when trainees violate certain conditions
Administrative Kill	7	7.0	Destroyed by an OC or through EXCON administrative kill

The statuses "Hit, no damage/effect" and "Miss" are in fact only temporary (transitory) statuses as a result of an engagement and in terms of capabilities they are the same as "operational". However they are listed in the table for backward compatibility with existing systems.

Also, the statuses "Tampering Kill" and "Administrative Kill" are in terms of capabilities the same as "Total kill", but listed in the table for backward compatibility with existing systems.

The treatments for infrastructure are different than those of personnel and vehicles due to the different nature. For example, infrastructure is not mobile and cannot communicate. However, it can engage other

DOs, but generally in response to being engaged itself (as a medium for the propagation of an engagement) such as when a wall that is hit and as a consequence it disperses debris, or when a person enters a CBRN contaminated room and consequently gets CBRN contaminated himself, or a person steps on a destroyed floor and consequently he gets wounded or killed.

Infrastructural objects do have other capabilities though, depending on the type of infrastructure. From a tactical training point of view, a wall provides cover (protection) for DOs positioned behind. In reality a wall also provides concealment (hiding from detection), but this capability is yet difficult to influence in a live training environment (unless a see-through property is implemented). A ceiling provides top cover, but also supports other DOs to stand and move or take up fire positions on it. A door generally does not provide any cover, but allows access through a wall (when opened, or hinders it when closed or blocked. And so, many other examples can be given.

The statuses of infrastructural objects must be related to their capabilities. The first level statuses "Operational" and "Destroyed" are straightforward: the capabilities are fully available or not existent anymore. As opposed to personnel and vehicles, the status "Damaged" does not mean that a subset of its capabilities is not available anymore (e.g. not able to move or fire or both), but that the performance of one capability is degraded. For example a damaged wall will not provide protection anymore against heavy calibre ammunitions, but only against small calibre ammunitions. As another example one could define that a damaged bridge will not support vehicles of 60 tons anymore, but only vehicles of 30 tons or less. In addition to degraded performance, infrastructure can also be reinforced, resulting in improved performance.

A solution to deal with the complexity of the statuses of infrastructure at the lower levels has two dimensions, namely categories and meaning.

1) Categories:
    a) It is possible to define a specific set of statuses for each type of infrastructure and relate those statuses to degrees of degradation of the associated capability or capabilities.
    b) As an alternative, the first level status "Damaged" can be decomposed into several statuses at level two denoting a certain percentage of the remaining capability or capabilities. Advantage is that these statuses are applicable to all types of infrastructure.

2) Meaning:
    a) The operational consequences of each status are clearly defined and standardised among the different training systems.
    b) The operational consequences of each status are left to the responsibility of each training system.

From a standardisation point of view the first option is preferred, but this requires common practice and understanding from the nations, which does not yet exist. The disadvantage of the second option is that when two or more training systems have assigned a different meaning to a certain status, this could lead to confusion and even negative training value for the trainees. For example, if 50% damage in system A means protection against a certain type of ammunition, while in system B it means no protection against that type of ammunition.

Because infrastructure generally belongs to a training site and it is highly unlikely that visiting trainees will bring their own infrastructure (as opposed to personnel and weapon systems), the infrastructure in one training location will be managed by one training system and thus only one definition of infrastructure statuses will apply. That definition might be different than what the visiting trainees are accustomed to. In that case clear communication and coordination before the start of the training is required to avoid misinterpretation.

Different infrastructural objects (each modelled as DO) can make up a higher order infrastructural object, the typical example being walls, a floor and a ceiling making up a room. And several rooms grouped together make up a house. In many cases the engagements or effects of the higher order object are those generated by its subordinate objects. For example, entering a destroyed room can result in a total kill, because the floor of that room is destroyed and causes to kill the DO stepping on it.

However, there are example situations when the higher order object needs a status of its own and must be able to engage other DOs by itself and thus be modelled as a DO. An example is that a room is declared out of bounds, while the room is not destroyed.

From a standardisation point of view, the damage statuses of infrastructural objects are the least important. Given the UCATT functional architecture, it is assumed that engagements and associations involving infrastructure are handled by those infrastructural DOs or the host training system. So unless one brings one's own infrastructural objects to training system, these damage statuses must be standardised or harmonised.

D.2 GENERAL REMARK

It is only useful to define statuses for DOs when each status can be represented in the training environment, either visually (light, smoke, sound, etc.) or that the status can be retrieved for the DO in a way that resembles reality (e.g. medical diagnosis requires the medic to make physical contact with the wounded person).

Annex E – E1: DO ENGAGEMENT

E.1 INTRODUCTION

This annex describes the data elements that are required to simulate an engagement. In the UCATT context an engagement represents an action on a dynamic object. Examples are:

- Direct or indirect fire from a shooter to a target.
- An IED explosion affecting dynamic objects in its influence sphere.
- Medical treatment of a medic on a wounded person.
- A repair action by a maintenance engineer on a damaged vehicle.
- An O/C action on a Dynamic Object (DO).

In the tables below the superset of data elements for several types of engagement is defined.

The tables contain different columns defined as:

1) **Parameter**: This is a data element required to simulate an engagement.
2) **Purpose**: The reason the data element is required. Several categories are used:
   a) TARGETING: The data is used to determine which and where dynamic object(s) is or are affected by the engagement.
   b) DAMAGE CALCULATION: The data is used to determine the outcome of the engagement.
   c) MONITORING: The data is used for on-line monitoring of the execution of the exercise and system performance and for After Action Review, the evaluation and feedback of the performance towards the Training Audience (TA).
   d) ANALYSIS: The data is used for other purposes, e.g., statistical or trend analysis, not directly used for monitoring or feedback towards the TA.
3) **Unit**: The unit in which the data element is expressed, e.g., distance or location in meters, time in seconds. When the data is a system internal identifier, it is expressed as dynamic object ID or category.
4) **Max**: The maximum value of the data element.
5) **Accuracy**: The required accuracy of the data element, expressed in (sub-) units. This means that the actual value of the data element must be expressed in multiples of the mentioned accuracy.

E.2 CONTACT AND PROXIMITY ENGAGEMENTS

Table E-1 contains the data for contact and proximity engagements. A contact engagement is an engagement where a projectile hits the target, e.g., a bullet or an anti-tank high explosive round. A proximity engagement is an engagement where the ammunition does not hit a target, but it explodes in the vicinity of a target and thereby affects it, e.g., an ammunition with a time or proximity fuse.

Table E-1: Superset of Data for Contact and Proximity Engagements.

Parameter	Purpose	Unit	Max	Accuracy
Shooter ID	MONITORING	ID	100,000	–
Shooter location (x, y, z), plus accuracy indicator	TARGETING MONITORING	Meter	World coordinate	Sub-decimeter
Shooter velocity (vector), plus accuracy indicator	TARGETING MONITORING	Meter/sec		Meter
Weapon type	TARGETING MONITORING	Category		–
Weapon ID	ANALYSIS	ID	100	–
Shooter weapon mode	TARGETING MONITORING	Category		–
Weapon direction/angle (vector), plus accuracy indicator	TARGETING			VERY HIGH
Ammunition type	DAMAGE CALCULATION MONITORING	Category		–
Fuse type	TARGETING MONITORING	Category		–
Fuse settings	TARGETING MONITORING			–
Engagement range	DAMAGE CALCULATION MONITORING	Meter		Meter
Detonation location (x, y, z), plus accuracy indicator	DAMAGE CALCULATION MONITORING	Meter		Sub-decimeter
Effect direction/angle (vector) at the moment of detonation	DAMAGE CALCULATION MONITORING			HIGH
Projectile impact velocity (vector), plus accuracy indicator	DAMAGE CALCULATION	Meter/sec		As required
Effect volume	DAMAGE CALCULATION MONITORING	Meter		Meter
Terrain	TARGETING DAMAGE CALCULATION	Meter		Sub-decimeter
Atmospheric data	TARGETING			–
Affected DO(s) ID	DAMAGE CALCULATION MONITORING	ID		–

Parameter	Purpose	Unit	Max	Accuracy
Affected DO(s) location (x, y, z), plus accuracy indicator	TARGETING MONITORING	Meter	World coordinate	Sub-decimeter
Affected DO(s) velocity (vector), plus accuracy indicator	TARGETING MONITORING	Meter/sec		Meter
Time of start of the engagement (trigger time), plus accuracy indicator	TARGETING MONITORING	Seconds		Micro-second
Time of end of the engagement (impact time), plus accuracy indicator	TARGETING MONITORING	Seconds		Micro-second
Point of impact	DAMAGE CALCULATION	Meter		Sub-decimeter

The properties of the target are also very important to calculate the results of the engagement. Properties such as its current operational status (damaged or not), its level of protection (wearing body armour or NBC mask), etc. However, this is not part of the engagement. The engagement ends when it affects the target. The engagement function will trigger another function, which determines the effect(s) of the engagement.

General Remark about Locations, Velocities and Angles

For some (types of) engagement a high accuracy of the locations, velocities and angles of the involved Dynamic Objects is required to determine the results of the engagement. For example, a difference of 1 degree of the direction of the firing weapon can be the difference between a hit or a miss. Also, in the confined spaces of the urban environment, soldiers can be very close to each other or can take cover behind a pillar or other (small) object. In the simulation environment an engagement must affect only those dynamic objects that would be affected in reality. Thus, for example, a bullet from a small arms weapon has only a very small area of effect, therefore the flight path and point of impact require a high level of accuracy. On the other hand, when using weapons or ammunitions with a large area effect, a (far) lesser level of accuracy is required. Therefore, for each of these types of data element, an indicator of accuracy is required, to identify the accuracy of the supplied data and determine the (fidelity) of the engagement results.

Shooter ID

The unique identifier to identify the Dynamic Object that causes the engagement. It is assumed that based on this ID the characteristics of this DO can be retrieved, such as the type (e.g., tank or infantry) or the name of the player or crew members. Three example situations can be distinguished:

- The weapon used in the engagement is an integral part of a DO and has no DO ID of itself, e.g., the main gun of a tank. The shooter ID in this example is the ID of the tank.
- The weapon used is not an integral part of the DO, but can be used by other DOs during the same exercise, and the weapon is not modelled as a DO. This is called equipment pairing (see main document Section 3.3.4.3). A typical example is a rifle that can be handed over to another soldier. The shooter ID in this example is the ID of the soldier, not of the rifle.
- The weapon used is modelled as a DO itself and (therefore) can be used by other DOs during an exercise. A typical example is a crew-served machine gun operated by two soldiers. The shooter ID in this example is the ID of the machinegun, not of (one of) the soldiers who operate the gun.

The identity of the soldiers can be retrieved through DO association (see main document Section 3.3.4.4).

Shooter Location (x, y, z)

The three-dimensional position of the shooter at the start of the engagement.

Shooter Velocity (Vector)

The three-dimensional speed of the shooter at the start of the engagement. This is for example required for targeting purposes, to determine the correct lead angle. It can also be used for monitoring purposes when training skills of crews of moving (stabilised or non-stabilised) weapon systems.

Weapon Type

The type of the weapon that is used to execute the engagement, such as launching the ammunition. For example an M-16 assault rifle or a 120 mm gun of a main battle tank. It is used mainly for monitoring purposes, because the effects of the engagement are not determined by the weapon type, but by the properties of the ammunition at the point of impact.

Weapon ID

When a weapon is an integral part of a DO (such as a coax machine gun on a tank or the different weapon systems on a naval vessel), this parameter identifies the weapon that was used in the engagement, relative to the Shooter ID. Land based systems generally have only a few weapons, but a battleship can have dozens of weapons installed on it, therefore the maximum value is set to 100.

Shooter Weapon Mode

The mode of the weapon at the moment of engagement. It contains for example the settings of a fire control computer, the used sighting device etc. It is used for correct targeting and monitoring purposes when training gunnery skills.

Weapon Direction/Angle

The direction/angle of the weapon at the moment of engagement, used for targeting, calculation of the trajectory of the fired ammunition. Because of this function, the accuracy of this parameter needs to be very high.

Ammunition Type

The type of the used ammunition, mainly used for damage calculation (can also be used for determining the trajectory of the projectile) and monitoring purposes.

Fuse Type

The type of fuse used for an ammunition. For certain ammunition types the operator can select the type of fuse, for example applicable to the “Bunkerfaust”, artillery and mortar rounds, HE kinetic rounds, etc. This determines whether the detonation of the ammunition is triggered by for example physical contact, time, a sensor (e.g., heat signature, radar signature, laser pointed) or a combination of triggers. The type of fuse determines the point of detonation and thus is used for targeting.

Fuse Settings

Depending on the type of fuse, certain settings can be applied. For example a time triggered fuse needs a specified time or delay after impact to detonate, while other fuses need a specified time after firing to become active (e.g., to allow a proximity fuse to be shot through foliage). The parameter is used for targeting.

Engagement Range

The distance over which a target is engaged. It is used for monitoring purposes but it can also be used for damage calculation, to take the effective range of the ammunition into account, to prevent that a weapon affects targets beyond its effective range (e.g., a pistol killing a target at 1,000 meter).

Note 1: When using a physical interface to transfer the engagement data between DOs based on line of sight (e.g., laser or RF), the range of the transfer method must be at least as large as the effective range of weapon and ammunition combination.

Note 2: Some current engagement systems use a separate ammunition code (called “ammunition ID”) to identify an ammunition which in fact is a combination of a general ammunition type, a fuse type, fuse setting and the distance (category) over which it is deployed. However, this is a typical implementation issue and such a parameter can be derived from other existing data elements.

Detonation Location

For proximity engagements, where the ammunition does not impact directly on a target, this is the three-dimensional location where the ammunition detonates. It is used to determine which DOs are affected.

Effect Direction/Angle (Vector) at the Moment of Detonation

The direction in which the effect of the ammunition is projected. This can be either omnidirectional (e.g., a hand grenade) or a particular angle or sector (e.g., a horizontal effect weapon). It is used to determine the direction of the influence sphere of the resulting explosion and thereby which DOs are affected by it. It can also be useful for monitoring purposes (e.g., evaluation of an ambush when using horizontal effect weapons).

Projectile Impact Velocity (Vector)

The three-dimensional speed of the projectile at the moment of impact. From this, the direction or three-dimensional angle of the projectile relative to the target can be inferred. It is used for damage calculation, for the speed and angle of impact are important factors to determine if the projectile penetrates the armour of a target, both for kinetic and high explosive ammunitions.

Effect Volume

The three-dimensional volume of effect of the exploding ammunition in which objects can be affected and used for damage calculation. However it can also be used for monitoring purposes to visualise the effect volume of the ammunition.

Terrain

The terrain is an important factor for targeting (for example is there line of sight between two DOs), projection of the trajectory of the projectile (e.g., are there any objects in between the shooter and target) and damage calculations (e.g., shielding a target from the detonation effects or reflection of blast).

Atmospheric Data

Atmospheric data contains information about for example wind direction and wind force, air pressure, temperature and humidity. It can influence the trajectory of projectiles. Advanced weapon systems take atmospheric conditions into account in their fire control computer.

Affected DO(s) ID

The unique identification of the Dynamic Object or Dynamic Objects that are affected by the engagement. In case of a shot from a rifle, it could be the single hit target. In case of an explosion of a bomb, it could be all the DOs that are present in the effect volume. It is used for damage calculation and monitoring purposes.

Affected DO(s) Location

The three-dimensional location(s) of the affected DO(s) at the start of the engagement, used for targeting and monitoring purposes.

Affected DO(s) Velocity

The three-dimensional speed of the affected DO(s), used for targeting and monitoring purposes.

Time of Start of the Engagement (Trigger Time)

The instance in time when the engagement starts, for example the time when a bullet is fired. When used for targeting purposes, a high level of accuracy is required (microseconds). When used for monitoring purposes, a lower level of accuracy is required (seconds).

Time of End of the Engagement (Impact Time)

The instance in time when the engagement ends, for example when a bullet hits a target or when an explosive round detonates. Used for targeting and monitoring purposes.

Point of Impact

The location on the target DO where the engagement affects the target. Typically it is the location where a bullet or other projectile impacts. It is used for damage calculation. When concerning human targets, it must be possible to at least make a distinction between the different body parts, therefore an accuracy of sub-decimeter magnitude is required.

Note: Some types of ammunition do not have their primary effect at the point of impact, but elsewhere. For example the Bunkerfaust dual purpose ammunition first penetrates a surface, before it explodes. The location of detonation can only be determined in combination with the properties of the affected target. When highly armoured, the ammunition will not penetrate the object or, conversely, when not armoured at all, the ammunition could fly through the object. It is assumed that the vulnerability model takes care of this calculation.

Examples

As stated, not all parameters are required for each engagement. Table E-2 shows three examples and the relevant data to characterise the engagement: a bullet hitting a target, a thrown hand grenade and a placed IED. There is no requirement to consider a hand grenade as a DO, whose location and status needs to be tracked during the exercise. It is sufficient to consider it as an ammunition (therefore, no “Ammunition ID” is required). However, for training purposes (especially training up to platoon level) it is relevant to record

who has thrown the grenade, hence the “Shooter ID”. Although technically not straightforward, a pairing is required between the shooter and the hand grenade.

Table E-2: Engagement Dataset for a Bullet, Hand Grenade and IED.

Bullet	Hand Grenade	IED
Shooter ID	Shooter ID	(Shooter ID)
Shooter location	Shooter location	(Shooter location)
Shooter velocity	Shooter velocity	(Shooter velocity)
Weapon type		
Weapon ID		
Weapon direction/angle		
Ammunition type	Ammunition type	Ammunition type
		Ammunition ID
Engagement range	Engagement range	(Engagement range)
	Detonation location	Detonation location
	Effect direction/angle	Effect direction/angle
Projectile impact velocity		
	Effect volume	Effect volume
Terrain	Terrain	Terrain
Atmospheric data		
Affected DO ID	Affected DO(s) ID	Affected DO(s) ID
Affected DO location	Affected DO(s) location	Affected DO(s) location
Affected DO velocity		
Trigger time	Trigger time	Trigger time
Impact time	Impact time	Impact time
Point of impact		

The IED is an interesting case in itself, because depending on the type of IED, certain parameters are required or not:

- In case of a Command IED (e.g., wire or radio controlled), the “Shooter ID” is the identification of the DO who set off the explosive. In general he will be at a certain distance from the IED, so also “Engagement range” is of significance.
- In case of a Victim Operated IED, also the “Shooter ID” is of interest, while at the same time the shooter will probably be also (one of) the “Affected DO(s)”. “Engagement range” does not seem to be a relevant parameter for this type of IED, since the explosive and the trigger device are generally close together in order to affect the victim.

From these perspectives a suicide IED can be modelled either as a mobile Victim Operated IED (when he sets the explosives off himself) or as a mobile Command IED (when somebody else remotely operates the explosives).

- In case of a Timed IED there is no shooter, but the explosive sets itself off at a specific instance in time. The player deploying the IED (the emplacer) is not part of the engagement and therefore not considered as the shooter.

E.3 MISSILE ENGAGEMENTS

The missile engagement is closely related to the contact and proximity dataset. In this case we will only look at the missile itself and not at the launcher, since the launcher is not part of the engagement. The capabilities launchers have are essentially similar in all available platforms, be it fixed-wing or rotary-wing aircraft, dismounted or vehicle mounted AT weapon systems, surface-to-surface, surface-to-air, air-to-air or air-to-surface. Launcher parameters are captured in the existing superset with the “Weapon Mode” line or can otherwise be differentiated with weapon or ammunition codes. The difficulty with the missile engagements is in the “delivery” part of the engagement, the part between launch and detonation or impact.

E.3.1 Types of Missiles

The difference between missiles is mostly determined by the kind of guidance system (if any) they use. There are a number of categories in which they can be divided:

1) Unguided missiles (rockets).
2) Unguided missiles (rockets) with advanced sighting system.
3) Command guided missiles:
    a) MCLOS (Manual Command to Line-Of-Sight).
    b) SACLOS (Semi-Automatic Command to Line-Of-Sight).
    c) Fire, observe and update (NLOS).
4) Fire-and-forget missiles.

E.3.1.1 Unguided Missiles (Rockets)

According to military definitions an unguided, powered projectile is called a rocket. Because of its propulsion method, size and common launcher characteristics we will still consider it to be a type of missile. They can either be shoulder-, vehicle- or aircraft-launched.

Examples: M-136, RPG-7, Carl-Gustav, Katyusha, Hydra 70.

E.3.1.2 Unguided Missiles, with Advanced Sighting System

Basically this is still the same type of weapon as the first category, in relation to targeting and guidance. The only difference with the first category are the advanced sights, which can give the weapon a lead angle capability and/or night-vision capabilities. In most cases the use of advanced sights extends the rockets effective range. Nevertheless, all these are capabilities of the sighting device and not the missile itself. Even though we already declared not to look at launcher capabilities, this type of weapon system is widely used and needs to be mentioned.

Examples: Panzerfaust 3 with Dynarange optics.

E.3.1.3 Command Guided Missiles

a) MCLOS (Manually command to line-of-sight)

This guidance method entails that both the missile and the target have to be tracked by the shooter, who steers the missile towards the target. The missile is typically steered by a joystick and communication to the missile is done by wire or radio link. Because of their low accuracy, difficult method of targeting (a lot of practice is needed) and the presence of newer techniques, these kinds of weapons are pretty much obsolete in modern day warfare.

Examples: AT-3 Sagger, Blowpipe, Saab Rb 05A, Azon.

b) SACLOS (Semi-automatic command to line-of-sight)

A command guided missile remains in contact with the launcher and needs to be steered manually towards the target by keeping the sights on target, until impact occurs. This gives the shooter the possibility to steer the projectile during flight toward a (for instance) moving target or switch to a different target. Communication between the launcher and the missile is either through wire and IR or radio. The difference with MCLOS is that the shooter only has to track the target, not the missile. Downside to both this method and the aforementioned MCLOS, is that even the slightest disturbance (explosions, enemy fire) or loss of concentration can cause a miss while the shooter has to remain on target (thus being visible to enemy troops, including the target) until impact.

A variation to this method of tracking is called line of sight beam riding (LOSBR), where the launcher projects a beam directly to the target, which is seen and followed by the missile. This tracking method is still considered to be in the SACLOS category, because of the targeting method from the launcher point of view. The sights (or Laser Target Designator for that matter) also have to stay on target until impact.

Examples: AT-4 Spigot, MILAN, M-47 Dragon, SA-8 Gecko, Starstreak.

c) Fire, observe and update (NLOS)

The latest generation of command guided missiles are closely related to fire-and-forget missiles and in some cases have the ability to switch between the two modes. The main difference with fire-and-forget missiles is that this type can switch targets in-flight and has the possibility of firing at targets that are not (yet) in line of sight (NLOS). They resemble the earlier SACLOS missiles, with the difference that fire, observe and update missiles can be “locked” instead of steered and in most cases have an extended range beyond line of sight. The “observe” function allows the shooter to view real-time IR imaging from the missile. He can therefore fire the missile “blind”, with no target locked, but can lock onto targets acquired in-flight.

Examples: Spike Extended Range.

E.3.1.4 Fire-and-Forget Missiles

These missiles require no further guidance after launch. All necessary data is programmed into the missile prior to launch by either a (thermal) image of the target, coordinates or radar information. After launch the sensors in the missile, combined with the input targeting information from the launcher, let it find its own way to the target without shooter interference. This category also covers anti-radiation and homing missiles that home in on heat (IR), negative UV or radio/radar installations automatically, with minimal crew input.

Examples: Spike Gill, Javelin, FIM-92 Stinger, AIM-9 Sidewinder.

E.3.2 Considerations

If we look at all different missile platforms as stated above, there are multiple ways to compare them. Simplified, they differ in the ability to influence them after launch and method of guidance.

E.3.2.1 Unguided Missiles (Rockets)

First we look at the first two categories of missiles as an example: the unguided missile or rocket (with or without advanced sighting). The outcome of the engagement is practically decided at trigger time. The shooter's aim is either good or bad, but after the trigger is pulled or the button pushed there is no influencing it anymore. In fact, an unguided missile is nothing more than a simple bullet in some way. The differences are its means of propulsion, the longer flight duration and the higher payload. If we consider these missiles to be a simple bullet (with or without proximity effects) they are covered in the earlier described datasets, with the exception of an extra parameter for the flight duration.

E.3.2.2 Fire-and-Forget Missiles

Be it more advanced, the fire-and-forget missiles are basically the same. At trigger time the outcome of the engagement (from the shooter's point of view) is basically decided, and again, no influence is possible in-flight.

Of course there are also factors of influence on the target side, but that calculation is done elsewhere. All information (the dataset) that is known at trigger time (from the shooter) can be sent at once, as it will not change during flight. Even though no further information is needed for guidance the flight duration of the missile has to be taken into account before any effect on the target can be declared.

E.3.2.3 Command Guided Missiles

If all other missiles are considered "advanced bullets with different propulsion and payload" and are covered by existing datasets, with and extra parameter for flight duration. This leaves us with only one category to cover; the ones that can be influenced by the launcher during flight. This category is more difficult as more factors are influencing the outcome of the engagement, over a longer period of time.

In an earlier stage it was decided that an engagement starts at the moment the trigger is pulled (or the button pushed) and that it ends at the moment of impact (or miss). For a command guided missile that means a couple of things happen at trigger time.

The **first** one is that a countdown timer starts ticking, which is basically a rendition of the missile's flight duration. Duration of flight is determined by multiple factors: distance to target, trajectory (weapon mode), ballistics, atmospheric data, vector of the launcher and vector of the target. All of this data is already in the existing dataset. The flight duration basically determines the window of time in which targeting corrections can be made.

The **second** deciding factor is where the sights are aimed at the moment the clocks stops ticking and "Time of impact (or detonation)" is reached. After that, damage calculation is done (or not, in case of a miss). The fact that there is a certain "slowness" in steering corrections (missile response time) should be implemented in the training system (e.g., corrections made just before impact have no effect anymore on the point of impact).

A **third** (auxiliary) factor that has to be taken in to account is the fact that the way targeting corrections are made by the launcher have to be given limitations. In reality, if the launcher makes a lot of sudden movements or moves with a high radial speed, he will "lose" the missile. Functionality has to be implemented in the training system to detect if the launcher exceeds its limitations and abort the engagement in-flight or determine whether a hit or miss occurs. Determining if the shooter stayed within given guidance limitations can be decided during or after the flight time has ended. To declare that to the target an additional parameter is introduced: "Engagement validation". Engagement validation is a flag whose value is determined by shooter performance during missile guidance and decides whether a hit or miss takes place.

An **additional** factor that can be into play is the presence of a target designator. The designator can assist the shooter in guiding the missile or take over guidance altogether. Since the shooter and the designator are not necessarily the same, but are part of the same engagement, additional parameters are needed. Assuming the designator can have the same role as the shooter, the same parameters are needed. These include designator ID, designator position (x, y, z) and vector (speed and direction). The designator ID is not only for monitoring purposes but for targeting purposes as well. When a designator assists a shooter, chances of a hit are normally greatly improved. Therefore, the presence of a designator has to be taken into account.

Equal to the shooter, the designator has to meet the same conditions in order not to lose guidance of a missile. When a shooter or designator makes too many, too sudden or too large movements, guidance should be lost.

It is noted that the fidelity of simulating the accuracy of missile guidance should be sufficient to ensure fair play between shooter/designator and target. For skill training, a higher level of fidelity might be required.

E.3.3 Conclusions

Missiles are a category of projectiles that differ from ballistic ammunition in propulsion, targeting/homing capabilities, flight duration, trajectory and payload. Propulsion is irrelevant in this case because it is not simulated. Payload is a parameter that is important for damage calculation but in the end nothing more than a weapon code and true pyrotechnic effects are also not simulated.

In a simulation sense it is targeting we are mostly interested in as it is more difficult to simulate and highly important for the level of fidelity of the simulation.

There are several new parameters to be added to the dataset we determined for contact and proximity engagements. These are highlighted in orange in the table below. One of them is Duration of flight. The accuracy should be in microseconds, because of the high speed a missile can have and therefore the distance it can cover in a single time-frame.

As for fire-and-forget missiles, the time until engagement has to be declared to the target. However, this value is the same as the "Duration of flight" so no extra line needs to be added to the dataset. To keep engagements with fire-and-forget missiles fair, a certain hit probability has to be taken into account when calculating impact and damage.

Next to a shooter, a designator can be part of the same engagement (one missile, one target). He can assist the shooter for a higher accuracy of targeting or he can take over the missile guidance entirely. In the case of assistance, providing a designator ID might be enough as a flag that gives higher accuracy. But since guidance can be completely taken over by the designator, the same parameters have to be known for the designator as well. These parameters, next to the designator ID, are its location and speed and direction (vector).

During flight the shooter or designator can move his sights around within limits of maximum radial speed or g-forces and within the duration of flight. The parameter "Engagement validation" signals whether the shooter or designator stays within these limits, and the point of impact is determined when the flight duration is reached.

E.3.4 Missile Engagement Superset

Designator properties, flight time and engagement validation are added to the direct engagement dataset and marked in orange.

Table E-3: Engagement Dataset for Missiles.

Parameter	Purpose	Unit	Max	Accuracy
Shooter ID	MONITORING	ID	15,000	–
Shooter location (x, y, z), plus accuracy indicator	TARGETING MONITORING	Meter	World coordinate	Sub-decimeter
Shooter velocity (vector), plus accuracy indicator	TARGETING MONITORING	Meter/sec		Meter
Designator ID	TARGETING MONITORING	ID	15,000	–
Designator location (x, y, z), plus accuracy indicator	TARGETING MONITORING	Meter	World coordinate	Sub-decimeter
Designator velocity (vector), plus accuracy indicator	TARGETING MONITORING	Meter/sec		Meter
Weapon type	MONITORING	Category		–
Weapon ID	ANALYSIS	ID		–
Shooter weapon mode	TARGETING MONITORING	Category		–
Trigger type of the event	ANALYSIS	Category		–
Weapon direction/angle (vector), plus accuracy indicator	TARGETING			VERY HIGH
Ammunition type	DAMAGE CALCULATION	Category		–
Ammunition ID	MONITORING	ID		–
Duration of flight	TARGETING	Seconds		Micro-second
Engagement range	DAMAGE CALCULATION MONITORING	Meter		Meter
Engagement validation	TARGETING	YES/NO		–
Detonation location (x, y, z), plus accuracy indicator	DAMAGE CALCULATION MONITORING	Meter		Sub-decimeter
Effect direction/angle (vector) at the moment of detonation	DAMAGE CALCULATION			HIGH
Effect volume	DAMAGE CALCULATION	Meter		Meter
Terrain	TARGETING DAMAGE CALCULATION	Meter		Sub-decimeter
Atmospheric data	TARGETING			–

Parameter	Purpose	Unit	Max	Accuracy
Affected DO(s) ID	DAMAGE CALCULATION	ID		–
Affected DO(s) location (x, y, z), plus accuracy indicator	TARGETING MONITORING	Meter	World coordinate	Sub-decimeter
Affected DO(s) velocity (vector), plus accuracy indicator	TARGETING MONITORING	Meter/sec		Meter
Time of start of the engagement (trigger time), plus accuracy indicator	TARGETING MONITORING	Seconds		Micro-second
Time of end of the engagement (impact time), plus accuracy indicator	TARGETING MONITORING	Seconds		Micro-second
Point of impact	DAMAGE CALCULATION	Meter		Sub-decimeter
Projectile impact velocity (vector), plus accuracy indicator	DAMAGE CALCULATION	Meter/sec		As required

E.3.4.1 Designator

It is possible that the weapon system or person who fires the missile, is not the same as who aims/guides the missile (the designator). Therefore there is a need to incorporate both the shooter properties and the designator properties (ID, location, velocity).

E.3.4.2 Duration of Flight

The duration it takes for the missile to fly from the moment of launch till the point of impact/detonation.

E.3.4.3 Engagement Validation

During the flight of the missile, the designator can adjust the flight path to compensate for movements of the target or even to switch to another target. However, when making too many, too large or too sudden adjustments, the designator can lose the control over the missile. Only when the designator stays within the limits of these conditions, the missile can hit the target. It is noted that the fidelity of simulating the accuracy of missile control should be sufficient to ensure fair play between designator and target. Skills training for the missile designator could require a higher fidelity simulation.

E.3.5 Final Thoughts

The missile engagement dataset is one of the more challenging datasets to be covered under the UCATT standard.

The proposed solution for missile engagement is not perfect. It has some flaws and loopholes. From fair play perspective however, it is probably sufficient to meet training needs at this moment. Future technology advancement might provide higher levels of fidelity and have to be addressed in future versions of the UCATT standard.

E.4 AREA ENGAGEMENTS

There can be certain areas in the environment that can affect the status of DOs. An area engagement is defined as the situation where the location of such an area and the location of a DO coincide. The engagement ends when the DO leaves the area, the area ceases to exist or the DO is killed.

E.4.1 Minefields

Minefields are a collection of mines located in the same area. They can be simulated as individual mines, either physically placed in the live environment or virtually simulated in the training system ("EXCON"). In both cases the interaction with these mines is a contact or proximity engagement as described in Section D.2. Although the engagement is between an individual mine and one or more DOs, the minefield has a tactical relevance. For that reason it is important to know how many DOs were affected by the minefield, in other words, how effective the minefield was (and not only the individual mines). Therefore it is required that the mines can be grouped into a higher level concept of minefield, with a specific minefield identification.

However, there are also training systems that simulate a minefield as an area wherein a DO has a certain probability of getting struck by a mine, without simulating each individual mine. In this case and dependent upon the characteristics of the minefield (mine type, density etc.), "a dice is rolled" for any DO upon entering the minefield and in better systems this continues whilst the DO move within the minefield. This is a Monte-Carlo simulation.

Simulation of individual mines is a more realistic implementation. For backward compatibility reasons the implementation of minefields as probability areas is taken into account.

In UCATT terms a probability area is not considered as a DO itself, but part of EXCON, and therefore the interaction with DOs is part of E3, "Control Dynamic Object Status". But given the close relation with interactions between DOs they are defined in this annex.

E.4.1.1 Minefield Creation and Deactivation

Table E-4: Minefield Creation Dataset (When Modelled as Probability Areas).

Parameter	Purpose	Unit	Max	Accuracy
Minefield ID	MONITORING	ID		–
Emplacer ID	MONITORING	ID	15,000	–
Minefield location	TARGETING	Meter	1,000	Sub-decimeter
Ammunition type(s)	DAMAGE CALCULATION	Category		–
Ammunition type density	TARGETING	Mines/m^2		0.01
Activation time	TARGETING	Seconds		Second

Minefield ID

Unique identifier identifying a minefield.

Emplacer ID

The identification of the DO that created the minefield. Minefields can be created by a minescattering vehicle, delivered by artillery (FASCAM), by air or can be hand emplaced. In training systems they can also be laid by EXCON. When applicable, for monitoring purposes, the ID of the emplacer can be recorded.

Minefield Location

The location of the minefield, defined as a polygon (square, rectangle or other more complex pattern). The corners of the polygon are to be specified with an accuracy of a sub-decimeter. This high accuracy is required because in an urban environment the locations of DOs are also very accurate. It is also noted that minefields in an urban environment are smaller than tactical minefields in open country to deny access to large fields and block access ways.

Ammunition Type(S)

The type(s) of mine of which the minefield is made up. A minefield can contain multiple types of mines (e.g., a combination of anti-personnel and anti-tank mines).

Ammunition Type Density

The number of mines per square meter, specified for each type of mine in the minefield. Typically, mines are laid in rows and a density of an order of magnitude of 0.4 mines/m2 is considered sufficient to create an effective minefield. But it must also be possible to create large minefields with a smaller density, hence the accuracy of 0.01 mines/m^2.

Activation Time

The instance in time when the minefield is laid or activated.

Deactivation Time

The instance in time when the minefield is cleared or deactivated.

Table E-5: Minefield Deactivation Dataset (When Modelled as Probability Areas).

Parameter	Purpose	Unit	Max	Accuracy
Minefield ID	MONITORING	ID		–
Deactivation time	TARGETING	Seconds		Second

E.4.1.2 Minefield Engagements

Table E-6: Minefield Engagement Dataset (When Modelled as Probability Areas).

Parameter	Purpose	Unit	Max	Accuracy
Minefield ID	MONITORING	ID		–
Engagement time	MONITORING	Seconds		Second

Parameter	Purpose	Unit	Max	Accuracy
Terrain	TARGETING DAMAGE CALCULATION			–
Affected DO(s) ID	DAMAGE CALCULATION	ID		–
Affected DO(s) location	DAMAGE CALCULATION	Meter		–

Engagement Time

The instance in time when the DO is engaged (the dice is rolled). A DO can be engaged multiple times by the same minefield (as long as he keeps moving in the minefield).

Terrain

The soil can influence the triggering of buried mines and can also influence the damage to DOs.

Affected DO(s) ID

The identification of the DO(s) that are affected by the engagement. Although one DO can trigger a mine, multiple DOs in its direct vicinity might be affected.

Affected DO(s) Position

The three-dimensional location(s) of the affected DO(s).

E.4.1.3 Clearing of Mines and Minefields

E.4.1.3.1 Clearing a Single Mine or IED

For the case where a single device (mine of IED) is deployed there are several possibilities to clear it:

- Shooting at it. This means the mine has to be visible in the training environment and the mine needs to be modelled as a DO, able to sense it is shot at. Under these conditions this is a contact engagement.
- Placing and initiating an explosive charge next to it. If the mine and explosive charge both are modelled as a DO, this is a proximity engagement.
- If there is a requirement that the mine can be influenced by fire support (artillery or aerial bombs), this can be modelled as an artillery area engagement.
- EOD clearance. Depending on the type of mine or IED, the EOD operators will take the appropriate measures regarding the device. It is important that the deployment of an EOD team and the required conditions and associated timings can be simulated. Therefore it will suffice that the training system allows the operator to initiate the type of activity and subsequently after a specified time the status of the mine or IED will be changed. The exact operations on the device with realistic sensitivity do not need to be simulated.

The engagement therefore requires the datasets presented in Table E-7.

Table E-7: Mine Clearing Dataset.

Parameter	Purpose	Unit	Max	Accuracy
Operator ID	TARGETING	ID		–
Mine ID	TARGETING	ID		–
Activity	DAMAGE CALCULATION	Category		–
Time of start of the engagement	TARGETING MONITORING	Seconds		Second
Time of end of the engagement	TARGETING MONITORING	Seconds		Second

Operator ID

The DO that attempts to clear the mine of IED. If required, this ID can be used to determine if the operator is qualified to clear the mine, influencing the result of the activity.

Mine ID

The identification of the mine or IED that is to be cleared.

Activity

The activity that the operator has chosen to clear the mine or IED.

Time of Start of the Engagement

The instance in time the clearing activity is started.

Time of End of the Engagement

The instance in time the clearing activity is interrupted or ended, resulting in a changed state or not.

E.4.1.3.2 Clearing a Minefield

For the case where a conventional minefield is deployed and which is created using the probability area method there are several possibilities to clear it or a path through it.

- Mine clearing vehicle. When the vehicle satisfies certain conditions (such as “in mine clearing mode” and “does not drive faster than mine clearing speed”), contact mines in the minefield will have no major effect on the vehicle and it will create in its wake a safe passage lane. However, a mine clearing vehicle typically can only sustain a certain number of blasts, depending on the type of mine. This functionality is part of the damage model of the vehicle.
- Dismounted mine clearing team. It is important that the deployment of a mine clearing team and the required conditions and associated timings can be simulated. It will suffice that the training system allows the dismounted team to traverse the minefield and when certain conditions are satisfied, a passage lane will be created in their wake.
- Explosive charges. Systems exist that can fire a rope of explosives which will detonate mines in the vicinity, thereby creating a passage lane. It is important that such a vehicle can manoeuvre on the

battlefield and initiate. Exact simulation of the explosive rope is not required, it suffices that they can notify EXCON who will create a passage lane.

- In reality it is possible that firing artillery on a minefield can displace or even destroy some mines. This can be modelled as a change of the hit probability of the minefield. However, since artillery cannot completely clear a minefield or even a safe passage lane, it is not required that artillery can influence minefields.

When the minefield is composed of individually modelled mines, the example situations are described in the previous paragraph.

E.4.1.3.3 Use of Minesweepers

- When used in combination with physically placed (simulated) mines, the real equipment can be used.
- Nowadays systems exist to instrument minesweeping equipment. It can be used to collect data on the use of minesweepers for monitoring purposes, so it can be determined if the users operate the equipment according to standard.
- Physical minesweeping equipment could be used in combination with virtual mines and minefields but since visual cues for the operators are an important part of the mine sweeping process and would not be easily available, this functionality is not required.

E.4.2 Fire Support Target Areas

A fire support target area is the 3-dimensional space where the ammunitions of a fire support mission land or detonate. This can be mortar or artillery fire or aerial bombardments. When fire support is modelled as (a series of) individual munitions, the interaction with the ammunitions are proximity engagements as described in Section D.2.

Fire support can also be simulated as an area wherein a DO has a certain probability of getting engaged by a delivered projectile, without simulating each individual projectile. Based on the characteristics of a fire support mission, a dice is rolled when and as long as the DO is within the influence of the active fire support target area. The implementation of fire support target areas as probability areas is taken into account.

Table E-8: Fire Support Engagement Dataset.

Parameter	Purpose	Unit	Max	Accuracy
Fire support target area ID	MONITORING	ID		–
Shooter ID	MONITORING	ID	15,000	–
Fire support target area location	TARGETING	Meter		Meter
Fire support target area shape	TARGETING	Meter	1,000	Meter
Ammunition type	DAMAGE CALCULATION	Category		–
Fuse type	TARGETING	Category		
Fuse settings	TARGETING			
Number of received salvo's	TARGETING	Integer		1

Parameter	Purpose	Unit	Max	Accuracy
Ammunition rounds per received salvo	TARGETING	Rounds/ salvo		1
Activation time	TARGETING	Seconds		Second
Deactivation time	TARGETING	Seconds		Second
Engagement time	MONITORING	Seconds		Second
Terrain	TARGETING DAMAGE CALCULATION			–
Affected DO(s) ID	DAMAGE CALCULATION	ID		–
Affected DO(s) location	DAMAGE CALCULATION	Meter		–
Angle of impact	DAMAGE CALCULATION			–

Fire Support Target Area ID

Unique identifier identifying a fire support target area.

Shooter ID

The identification of the DO that executes the fire support mission. However, it can also be a unit identification, since a fire mission is executed by one or more mortars, artillery guns, rocket launchers or airborne platforms. When applicable, it is used for monitoring purposes.

Fire Support Target Area Location

The location of the fire support area, expressed in world coordinates.

Fire Support Target Area Shape

The shape or volume of the fire support target area, defined as a polygon (square, rectangle or other more complex pattern). The boundaries of the polygon are to be specified with an accuracy of 1 meter.

Ammunition Type

The type of ammunition used in the fire mission.

Fuse Type

The type of fuse used for an ammunition. This determines whether the detonation of the ammunition is triggered by for example physical contact, time, a sensor (e.g., heat signature, radar signature, laser pointed) or a combination of triggers. The type of fuse determines the point of detonation and thus is used for targeting.

Fuse Settings

Depending on the type of fuse, certain settings can be applied.

Number of Received Salvos

Artillery is typically fired in layers: a number of guns fire, reload and fire again. This parameter is the number of salvos in the fire mission. This is seen from the target point of view: the number of times a series of shells explode roughly simultaneously. When artillery uses techniques like Multiple Rounds Simultaneous Impact (MRSI), a gun can fire several times consecutively, but the rounds impact at the same time, thus making up one received salvo. At each receiving salvo, the DOs can be engaged again.

Ammunition Rounds per Received Salvo

The number of shells per salvo. It is assumed the shells are evenly spread over the fire support target area, so from this parameter the density can be inferred (and thus the probability of being hit).

Activation Time

The instance in time when the fire support target area is activated (the first round detonates).

Deactivation Time

The instance in time when the fire support target area is deactivated (end of the fire mission, the last round detonates).

Engagement Time

The instance in time when the DO is engaged (the dice is rolled). A DO can be engaged multiple times by the same fire support target area (as long as he stays located in the fire support target area and rounds are being fired, typically at each salvo).

Terrain

The terrain can influence the damage to DOs, either (partly) shielding them from the fire support effects or even increasing the effects (e.g., firing in woods).

Affected DO(s) ID

The identification of the DO(s) that are affected by the engagement.

Affected DO(s) Position

The three-dimensional location(s) of the affected DO(s).

Angle of Impact

The angle at which shells fall influences their lethality. For example, mortar rounds come in at a very steep angle and consequently have a more or less proportionally omnidirectional effect. Artillery shells can come in at a lower angle, where part of the blast and fragmentation is dispersed in the ground and in the air.

E.4.3 CBRN Areas

CBRN areas are areas which contain a toxic agent and can affect DOs. CBRN areas come in, at least, two forms, a:

1) Contaminated area, which is static and sticks to the ground, infrastructure and other objects.
2) Cloud, which is dynamic and due to the influence of atmospheric conditions (wind, temperature, humidity, etc.), changes its location, shape, size and density (and therefore its effect) over time. It is assumed that the simulation of the dynamic behaviour of a CBRN area is a separate function, not part of the engagement.

A CBRN attack can result in both a static contaminated area and a dynamic cloud. In that case it is assumed that the attack resulted in two different CBRN areas, the static and the dynamic area.

E.4.3.1 CBRN Area Creation and Deactivation

Table E-9: CBRN Area Creation Dataset.

Parameter	Purpose	Unit	Max	Accuracy
CBRN area ID	MONITORING	ID		–
Shooter ID	MONITORING	ID	15,000	–
CBRN area location	TARGETING	Meter		Meter
CBRN area shape	TARGETING	Meter	10,000	Meter
Agent type	DAMAGE CALCULATION	Category		–
Agent density	DAMAGE CALCULATION	ppm		1
Activation time	TARGETING	Seconds		Second

CBRN Area ID

Unique identifier identifying a CBRN area.

Shooter ID

The identification of the DO that initiated the CBRN area. However, just like artillery, it can also be a unit identification, since a CBRN area can be caused by one or more actors. When applicable, it is used for monitoring purposes.

CBRN Area Location

The location of the CBRN area, expressed in world coordinates.

CBRN Area Shape

The shape or volume of the CBRN area, either defined as a two-dimensional polygon (for static contaminated areas) or as a three-dimensional polygon (for dynamic clouds). The boundaries of the polygon are to be specified with an accuracy of 1 meter.

Agent Type

The type of agent the CBRN area contains.

Agent Density

The amount of agent per volume, expressed as parts per million.

Activation Time

The instance in time when the CBRN area is activated.

Deactivation Time

The instance in time when the CBRN area ceases to be effective.

Table E-10: CBRN Area Deactivation Dataset.

Parameter	Purpose	Unit	Max	Accuracy
CBRN area ID	MONITORING	ID		–
Deactivation time	TARGETING	Seconds		Second

E.4.3.2 CBRN Area Engagements

Table E-11: CBRN Area Engagement Dataset.

Parameter	Purpose	Unit	Max	Accuracy
CBRN area ID	MONITORING	ID		–
Engagement time	MONITORING	Seconds		Second
Engagement duration	DAMAGE CALCULATION	Seconds		Second
Affected DO(s) ID	DAMAGE CALCULATION	ID		–
Affected DO(s) location	DAMAGE CALCULATION	Meter		–
Terrain	TARGETING			–
Atmospheric data	TARGETING			–

Engagement Time

The instance in time when the DO is engaged, upon entering the CBRN area.

Engagement Duration

The duration of time the affected DO is exposed to the CBRN area. The longer he stays within the CBRN area and is not properly protected, the more severe the effect will be.

Affected DO(s) ID

The identification of the DO(s) that are affected by the engagement.

Affected DO(s) Position

The location(s) of the affected DO(s).

Terrain

The terrain can influence the properties of the CBRN area.

E.4.4 CBRN Decontamination Areas

DOs can be decontaminated by special CBRN units. In reality, a CBRN unit will set up a decontamination station, where they will thoroughly clean contaminated vehicles and personnel. For training purposes in the tactical context of live instrumented exercises, it is sufficient to simulate a decontamination area and when certain conditions are satisfied (typically that a DO must remain for a certain period of time within the decontamination area), decontamination is considered successful. At this point here are no requirements to simulate decontamination vehicles, decontamination liquids, etc.

E.4.4.1 CBRN Decontamination Area Creation and Deactivation

Table E-12: Decontamination Area Creation Dataset.

Parameter	Purpose	Unit	Max	Accuracy
Decontamination area ID	MONITORING	ID		–
Shooter ID	MONITORING	ID	15,000	–
Decontamination area location	TARGETING	Meter	1000	Meter
Activation time	TARGETING	Seconds		Second

Decontamination Area ID

Unique identifier identifying a decontamination area.

Shooter ID

The identification of the DO that initiated the decontamination area. Typically it will be a unit identification. When applicable, it is used for monitoring purposes.

Decontamination Area Location

The location of the decontamination area, either defined as a two-dimensional polygon. The corners of the polygon are to be specified with an accuracy of 1 meter.

Activation Time

The instance in time when the decontamination area is activated.

Deactivation Time

The instance in time when the decontamination area is deactivated.

Table E-13: Decontamination Area Deactivation Dataset.

Parameter	Purpose	Unit	Max	Accuracy
Decontamination area ID	MONITORING	ID		–
Deactivation time	TARGETING	Seconds		Second

E.4.4.2 CBRN Decontamination Area Engagements

Table E-14: Decontamination Area Engagement Dataset.

Parameter	Purpose	Unit	Max	Accuracy
Decontamination area ID	MONITORING	ID		–
Engagement time	MONITORING	Seconds		Second
Engagement duration	DAMAGE CALCULATION	Seconds		Second
Affected DO(s) ID	DAMAGE CALCULATION	ID		–
Affected DO(s) location	DAMAGE CALCULATION	Meter		–

Engagement Time

The instance in time when the DO is engaged, upon entering the CBRN decontamination area.

Engagement Duration

The duration of time the affected DO is exposed to the CBRN decontamination area. Depending on the type of contamination of a DO, the DO must remain a certain amount of time within the decontamination area, before the decontamination is successful.

Affected DO(s) ID

The identification of the DO(s) that are affected by the engagement.

Affected DO(s) Location

The location(s) of the affected DO(s).

E.5 ENERGY WEAPONS

Energy weapons emit energy and thereby can influence Dynamic Objects. There are two types of energy weapons:

1) Weapons that emit one burst of energy, like for example a (nuclear) Electro Magnetic Pulse (EMP) or a flash-bang grenade, which generates simultaneously an intense flash of light and a pressure and

strong sound wave. These types of weapon can be modelled as a proximity engagement (see Section D.2).

2) Weapons that emit energy for a certain amount of time, typically the start and end time are under user control. For example sound waves or micro waves can be generated by a weapon when it is activated and the energy emission stops when the weapon is deactivated (trigger released). When the emission stops, also the influence stops. The emission of this type of weapons requires a new engagement definition.

When energy weapons emit energy during a certain timeframe, it is important to note that many of the engagement parameters can change during the engagement. For example, the shooter and target(s) can move, the direction of the weapon can change and maybe even the energy level can change.

Table E-15: Energy Weapons Engagement Dataset.

Parameter	Purpose	Unit	Max	Accuracy
Shooter ID	MONITORING	ID	15,000	–
Shooter location (x, y, z), plus accuracy indicator	TARGETING MONITORING	Meter	World coordinate	Sub-decimeter
Shooter velocity (vector), plus accuracy indicator	TARGETING MONITORING	Meter/sec		Meter
Weapon type	MONITORING	Category		–
Weapon ID	ANALYSIS	ID		–
Shooter weapon mode	TARGETING MONITORING	Category		–
Weapon direction/angle (vector), plus accuracy indicator	TARGETING			+/- 10% compared to actual weapon
Energy type	DAMAGE CALCULATION	Category		
Energy level	DAMAGE CALCULATION			
Effect volume	DAMAGE CALCULATION	Meter		Meter
Activation time	TARGETING MONITORING	Seconds		Second
Deactivation time	TARGETING MONITORING	Seconds		Second
Engagement time	MONITORING	Seconds		Second
Engagement duration	DAMAGE CALCULATION	Seconds		Second
Terrain	TARGETING DAMAGE CALCULATION	Meter		Sub-decimeter

Parameter	Purpose	Unit	Max	Accuracy
Atmospheric data	TARGETING			–
Affected DO(s) ID	DAMAGE CALCULATION	ID		–
Affected DO(s) location (x, y, z), plus accuracy indicator	TARGETING MONITORING	Meter	World coordinate	Sub-decimeter
Affected DO(s) velocity (vector), plus accuracy indicator	TARGETING MONITORING	Meter/sec		Meter
Point of impact	DAMAGE CALCULATION	Meter		Sub-decimeter

Shooter ID

The unique identifier to identify the DO that causes the engagement.

Shooter Location (x, y, z)

The three-dimensional position of the shooter during the engagement.

Shooter Velocity (Vector)

The three-dimensional speed of the shooter during the engagement, for targeting and monitoring purposes.

Weapon Type

The type of weapon that is used to cause the engagement, mainly used for monitoring purposes.

Weapon ID

The unique identification of the weapon that was used to cause the engagement.

Shooter Weapon Mode

The mode of the weapon during the engagement. It contains for example the settings of a fire control computer, the used sighting device, etc.

Weapon Direction/Angle

The direction/angle of the weapon, and thus that of the energy beam, during the engagement, used for targeting. If the energy beam is very narrow, e.g., a laser beam, the accuracy needs to be very high. If the energy beam covers an arc, the accuracy can be 1 degree.

Energy Type

The type of the emitted energy, used for damage calculation and monitoring. It is more specific than only the category. Like for example “sound” or “light”, but contains for example the used frequency or frequency range of sound or light energy.

Energy Level

It is possible that the shooter can set or control the level of the emitted energy, even during the engagement. This parameter specifies the power or intensity of the emitted energy.

Effect Volume

The three-dimensional space in which the emitted energy has an effect. Typically it will be a beam or a cone, having a direction, width, height and length. In practice a beam of energy generally will not have clear cut edges, but for simulation purposes this will suffice.

Activation Time

The instance in time when the energy weapon is activated and starts emitting energy. It is used for targeting and monitoring purposes.

Deactivation Time

The instance in time when the energy weapon is deactivated and stops emitting energy. It is used for targeting and monitoring purposes.

Engagement Time

The instance in time when the DO(s) are engaged, each upon colliding with the effect volume. Depending on the type of energy, the effect will be immediate, delayed or increase over time the longer the DO stays within the energy field.

Engagement Duration

The duration of time the affected DO(s) are exposed to the energy field.

Terrain

The terrain is an important factor for targeting and damage calculations.

Atmospheric Data

Atmospheric conditions can influence the effect of energy weapons.

Affected DO(s) ID

The unique identification of the DO(s) that are affected by the engagement.

Affected DO(s) Location

The three-dimensional location(s) of the affected DO(s) during the engagement, used for targeting and monitoring purposes.

Affected DO(s) Velocity

The three-dimensional speed of the affected DO(s), used for targeting and monitoring purposes.

Point of Impact

The location on the target DO where the engagement affects the target. In case of a narrow beam of energy, the accuracy needs to be sub-decimeter. In case of a wide beam of energy, the side of the target DO will suffice.

E.6 NON-LETHAL (OR LESS THAN LETHAL) WEAPONS

The purpose of NLW is to temporarily incapacitate the target, so the big difference with other types of weapons is that their effects are temporal, they do not require an explicit repair or heal action. NLW can partially or even totally incapacitate the target, but when terminating the engagement or after a limited amount of time, the effect degrades or wears off completely. This automatic change of the operational state of a DO is not part of the engagement, but it is important to realise that the implementation of NLW requires an extension of the simulation model of a DO, to take an incapacitation period into account.

With this mechanism also another effect can be simulated, namely the temporal incapacitation of personnel that is subject to a near miss of a large calibre round or the pressure wave of a nearby explosion. This temporal incapacitation represents the shock personnel suffers from when exposed to these types of event.

There are many types of NLW, however, their use can be modelled by the mechanisms and datasets described in the previous sections. For example, fired projectiles like rubber bullets, bean bags or even spider webs can be implemented as a contact engagement, requiring no additional parameters, but only a different ammunition ID and maybe a different weapon ID. Likewise, the firing of an electro shock gun can be modelled as a contact engagement, where the charge can be defined as ammunition ID. A flash-bang grenade requires exactly the same dataset as a lethal hand grenade, but based on its ammunition ID it will result in a different effect. Tear gas and other non-lethal substances can be modelled as categories of CBRN weapons. Laser dazzlers, sound waves and microwaves are energy weapons.

New developments of different types of NLW in the future may lead to an adaptation of the current types of engagements and their associated datasets.

E.7 JAMMERS

Jammers are devices that generate a "bubble" of electronic noise that disturbs the signal by which a Radio Controlled IED (RC-IED) is initiated, thereby preventing it from detonating. Also, as side effect, a jammer can disturb the radio communication of DOs that are located in the generated bubble.

Generally, jammers are associated with a DO, they are built in a vehicle or carried by a dismounted soldier. However, it is also possible to place a portable jammer on a certain location in the field, for example when investigating an IED. Therefore, jammers can be modelled as a property of a DO (when built into it) or as a separate DOs themselves (portable jammers that can be placed in the environment).

E.7.1 Jammer Activation and Deactivation

Table E-16: Jammer Activation Dataset.

Parameter	Purpose	Unit	Max	Accuracy
Carrier ID	MONITORING	ID	15,000	–
Jammer ID	MONITORING	ID		–
Jammer volume	TARGETING	Meter	1000	Meter
Jammer frequency list	DAMAGE CALCULATION	Hz		–
Jamming mode	TARGETING MONITORING			–

Parameter	Purpose	Unit	Max	Accuracy
Activation time	TARGETING MONITORING	Seconds		Second

Carrier ID

The identification of the DO that carries a jammer.

Jammer ID

If a jammer is modelled as a separate DO, it has its own ID and its own location.

Jammer Volume

The three-dimensional volume of the jammer, modelled as a sphere with a specific radius. If the jammer is off, the volume will be zero. In reality the volume of a jammer is not a sphere, but a complex volume depending on many different factors, amongst others shielding objects, such as the human body when the jammer is carried in a backpack. For training purposes it suffices to model the volume as a sphere.

Jammer Frequency List

The specification of the frequencies that are jammed by the jammer.

Jamming Mode

The mode in which the jammer is in.

Activation Time

The instance in time when the jammer is activated (switched on).

Deactivation Time

The instance in time when the jammer is deactivated (switched off).

Table E-17: Jammer Deactivation Dataset.

Parameter	Purpose	Unit	Max	Accuracy
Carrier ID	MONITORING	ID	15,000	–
Jammer ID	MONITORING	ID		–
Deactivation time	TARGETING	Seconds		Second

E.7.2 Jammer Engagements

Table E-18: Jammer Engagement Dataset.

Parameter	Purpose	Unit	Max	Accuracy
Carrier ID	MONITORING	ID	15,000	–
Jammer ID	MONITORING	ID		–
Affected DO(s) ID	DAMAGE CALCULATION	ID		–
Affected DO(s) location	DAMAGE CALCULATION	Meter		–
Terrain	TARGETING			–

Affected DO(s) ID

The identification of the DO(s) that are affected by the engagement, i.e. are inside the bubble of the jammer. It can either be RC-IEDs that are inhibited from detonating on command or DOs whose radio communication is hampered when their frequency is covered by the frequencies of the jammer.

Affected DO(s) Position

The location(s) of the affected DO(s).

Terrain

The terrain can influence the shape of the bubble, objects in the terrain can diminish or shield the bubble.

E.8 C4I INTERROGATION AND THREAT WARNING SYSTEMS

Weapon systems and personnel can be equipped with systems that allow them to recognise or identify friendly entities, distinguishing them from other or hostile entities. Terms used are Combat Identification systems or Identification Friend or Foe (IFF) systems. Comparable systems, but with a different purpose, are systems that can detect when they are interrogated or "hit" by an energy emission, such as a (hostile) laser beam. Generally, these operational systems can be used in the live training environment. When threat warning systems can automatically initiate counter measures, it may be required for safety purposes to inhibit the actual execution of these counter measures.

From a training system perspective, these systems are considered as operational C4I systems, which do not require the definition and implementation of simulated engagements. However, it is required that the active use of interrogation systems (when were what codes transmitted by whom and received by whom) and the activation of threat warning systems (when were what signals received by whom and what warnings were issued) are logged and made available for monitoring and analysis purposes.

E.9 REPAIR AND MEDICAL ACTIVITIES

During operations (minor) damages to vehicles and large weapon systems can be repaired in the field, either by the crew themselves or by combat service support units. When repair is not possible in the field, damaged equipment can be recovered and transported to a higher level repair facility.

Similarly, wounded personnel can be treated in the field by other (medical) personnel. When treatment cannot be executed or completed in the field, wounded personnel is transported or evacuated to higher echelon medical facilities.

These repair and medical activities greatly influence the tactical operation: they consume resources for execution, they require protection, they take time and the results of the activities influence the combat power of a unit. Therefore it is important that these functionalities can be trained in the context of live tactical training exercises. The primary training audiences of these activities might not even be the performers themselves, but the command and control levels that direct the operation.

Higher echelon facilities, such as repair centres or field hospitals (role 1 and higher) are generally not part of tactical exercises. At least there is no requirement to simulate or instrument them in the live environment; those functionalities, if required, can be simulated by EXCON.

E.9.1 Equipment – Repair Activities

The basis for repair activities is the simulated damage statuses of the DOs, possibly complemented by additional status information that can be retrieved for diagnosis. The more detailed the status information is, the more distinction can be made in the associated repair activities. For example, if the status of a DO is limited to “operational”, “mobility kill” and “total kill”, a repair activity cannot be more detailed than simply to restore the mobility. However, if the status can make a distinction between a mobility kill due to engine failure or a track or wheel fallen off, a repair activity can be more specific. Similarly, a distinction can be made between who is capable or authorised to execute the repair. In the example of a detailed mobility kill, the crew could repair the track or wheel fallen off themselves, while a recovery team is required to change the engine.

In order to enable the implementation of repair activities, it is required that players can diagnose the sustained damage of a DO and can interact with the DO to change the degraded status by means of a simulated repair activity. How these interactions are physically implemented is not prescribed. But one can for example think of a display in or on a vehicle to read off the damage status and select the proper repair activity. For weapon systems that have an advanced C4I system that can register the status of the weapon system, the simulated damage state can be communicated through that C4I system.

Of course the physical actions to perform the repair do not need or even cannot be executed in the live training environment. Instead it is sufficient that after initiating the repair activity, a certain repair time is taken into account. Only after that time period has finished, the repair is considered to have taken place successfully and the damage status will be changed. During the repair time the damage status and the associated limitations for the vehicle and crew will stay in effect.

Some users of live training systems can choose to require additional functionality regarding repair activities that is currently not part of the UCATT standard. The current UCATT requirements are considered to satisfy the relevant training objectives. Such additional functionality could be to implement conditions that must be satisfied during the repair activity to be effective, for example when the repairing DO is killed, the repair is cancelled. Or when the repairing DO and the DO to be repaired are separated more than say 50 meters, the repair is also cancelled (to prevent that one repairer can activate multiple repair activities simultaneously, which he couldn’t do in reality). When a repair activity is cancelled, one can then decide to require that a new repair activity starts the repair process all over again or should continue where the previous repair activity left off.

It is currently assessed that it suffices to record only the ID of one repairing DO, this can be the ID of the person who initiates the repair activity or the ID of the vehicle (unit) that person belongs to. In reality, a repair activity can be executed by multiple persons working as a team, for example changing a vehicle

engine in the field generally involves the whole crew of a repair vehicle. Administrating the IDs of all persons involved in the repair activity is currently not required. If that would be required, one can even decide that the number of persons working on the repair influences the repair time (the more the faster) or influences the repair result (for example changing an engine cannot be done by one person alone). But as stated, since repair activities probably can only be performed with a low level of fidelity in a live training environment, such requirement are considered to be outside the scope of the training objectives.

Repair activities in the field that must be supported by the training system can be performed by:

- The crew of the damaged vehicle. The repair activities are limited to those activities that the crew can perform by themselves in reality. Since this is only a very limited set of activities, this possibility has a low priority.
- The crew of a recovery vehicle. They have more knowledge, skills, tools and spare parts than the crew of the damaged vehicle and therefore they can repair more serious damage.
- If the damage cannot be repaired in the field, the damaged vehicle can be transported to a repair facility. This recovery can be executed in the live environment, without need for special training equipment functionality.
- Members of EXCON, including O/Cs in the field. EXCON must have the possibility to initiate a repair activity, either taking into account the repair time it would take another actor (the crew themselves or the crew of a recovery vehicle), or instantaneously. This latter possibility is useful to make optimal use of the training time.

  Note that for analytical and monitoring purposes it is useful to make a distinction between an instantaneous EXCON repair and an EXCON reset. Although the effects are exactly the same (both can result in immediately changing the damage status), an EXCON repair is within the tactical context of the exercise, while an EXCON reset is an intervention outside that scope, e.g., due to a (sub)system failure, therefore the data in the generated reports will be treated differently.

It is assumed that one repair activity will repair only one type of damage. Multiple damages require multiple repair activities that could be executed simultaneously or successively. For example, to repair a communication kill and a mobility kill, requires a “repair communication system” and a “repair engine”. Those repair activities can be executed by the same repair DO or by two separate repair DOs.

Table E-19: Repair Engagement Dataset.

Parameter	Purpose	Unit	Max	Accuracy
Repair DO ID	ENGAGING MONITORING	ID	15,000	–
Repair DO location (x, y, z), plus accuracy indicator	ENGAGING MONITORING	Meter	World coordinate	Meter
Repair activity ID	EFFECT CALCULATION MONITORING	ID	100	–
Engagement time	MONITORING	Seconds		Second
Repair duration	EFFECT CALCULATION MONITORING	Number	43,200 seconds (12 hours)	Second

Parameter	Purpose	Unit	Max	Accuracy
Affected DO ID	ENGAGING MONITORING	ID		–
Affected DO location (x, y, z, plus accuracy indicator	ENGAGING MONITORING	Meter	World coordinate	Meter

Repair DO ID

The ID of the DO that performs the repair activity. This is required to determine if the DO is permitted or has the capability to perform the repair activity. Also for analytical and monitoring purposes the IDs of the involved DOs are required.

Repair DO Location

The location of the repair DO, mainly used for monitoring purposes, but conditions can be checked that the repair DO must be in the direct vicinity of the DO to be repaired.

Repair Activity ID

The activity identification of the initiated repair activity.

Engagement Time

The instance in time when the repair activity starts and is mainly used for monitoring purposes.

Repair Duration

The duration in seconds of how long the repair activity will take to become in effect. This can be zero, to immediately change the damage status of the affected DO. In practice, the duration of a repair activity is generally measured in minutes, rather than seconds.

Affected DO ID

The ID of the DO to be repaired.

Affected DO Location

The location of the DO to be repaired.

There will be a mapping of which (type of) DO are allowed to perform what repair activities on what type of damaged DO. Those permissions are considered as properties of the DO that wants to perform a repair activity and are therefore not part of the engagement data. If a DO has insufficient permission to perform a particular repair activity, either he cannot select or initiate such activity or the activity will have no effect.

E.9.2 Personnel – Medical Treatment

Medical treatment of wounded personnel is from the perspective of the training system quite similar to repair activities regarding damaged equipment. Also here the health status of the DO, possibly complemented by additional status information that can be retrieved for diagnosis is the basis for medical treatment. The more detailed the information is, the more distinction can be made in the associated medical activities. And likewise, a distinction can be made between who is capable or authorised to execute a medical treatment.

There is one big difference with repairing equipment. Given the level of detail in the training system, a damage to a piece of equipment will generally not get worse by itself, to change the system state of a DO an external interaction or engagement is required. Repair activities aim to improve the status of a DO.

For wounded personnel however, in reality when a wound is not treated, the situation will deteriorate and the victim will lose capabilities and can eventually die. When the training system supports a rich set of health statuses and associated diagnostic data for personnel, it is also logical that there is a simulation model that determines such degradation of the health status. The purpose of medical treatment in the field is to stop or slow the deterioration of the health of a wounded person. Actual healing of a wound will generally require medical facilities and will take more time than is available in the exercise. It should also be possible for an affected DO's health to deteriorate when the wrong treatment is given, even faster than when no action is taken at all. Therefore a treatment can have a negative effect.

In order to enable the implementation of medical treatment, it is required that players can diagnose the health status of personnel DOs and can interact with the wounded DOs to change the health status by means of a simulated medical activity. How these interactions are physically implemented is not prescribed.

The physical activities to treat a wounded person do not need or even cannot be executed in the live training environment. It is sufficient that relevant timing conditions are taken into account (e.g. pressure must be applied for a certain period) in order to consider the treatment as successful.

Medical treatment activities in the field that must be supported by the training system can be performed by:

- The wounded DO itself (care under fire). The associated medical activities are limited to those activities that a person can perform by himself in reality, such as taking medication or applying pressure to stop a bleeding.
- Any non-medical personnel, also they are only capable to perform very basic medical activities.
- Medically trained personnel. They have more knowledge, skills and tools and therefore can perform more complicated medical activities. They also can decide on medical evacuation or transportation to a medical facility. This transportation can be executed in the live environment, without need for special training equipment functionality.
- Members of EXCON, including O/Cs in the field. EXCON must have the possibility to initiate a medical treatment, either taking into account the treatment time it would take another actor or instantaneously. For analytical and monitoring purposes it is useful to make a distinction between an instantaneous medical treatment and an EXCON reset.

Table E-20: Medical Engagement Dataset.

Parameter	Purpose	Unit	Max	Accuracy
Medic DO ID	ENGAGING MONITORING	ID	15,000	–
Medic DO location (x, y, z), plus accuracy indicator	ENGAGING MONITORING	Meter	World coordinate	Meter
Medical activity ID	EFFECT CALCULATION MONITORING	ID	100	–
Engagement time	MONITORING	Seconds		Second

Parameter	Purpose	Unit	Max	Accuracy
Treatment duration	EFFECT CALCULATION MONITORING	Number	43,200 seconds (12 hours)	Second
Affected DO ID	ENGAGING MONITORING	ID		–
Affected DO location (x, y, z), plus accuracy indicator	ENGAGING MONITORING	Meter	World coordinate	Meter

Medic DO ID

The ID of the DO that performs the medical activity.

Medic DO Location

The location of the medic DO, mainly used for monitoring purposes, but conditions can be checked that the medic DO must be and stay during the medical treatment in the direct vicinity of the wounded DO.

Medical Activity ID

The activity identification of the performed medical activity.

Engagement Time

The instance in time when the medical treatment starts and is mainly used for monitoring purposes.

Treatment Duration

The duration in seconds of how long the medical activity will take to become in effect.

Affected DO ID

The ID of the DO to be treated.

Affected DO Location

The location of the DO to be treated.

There will be a mapping of which (type of) DO are allowed to perform what medical activities on what wounds. Those permissions are considered as properties of the DO that wants to perform a medical activity and are therefore not part of the engagement data. If a DO has insufficient permission to perform a particular medical activity, either he cannot select or initiate such activity or the activity will have no effect.

E.10 LOGISTICS

During actual operations supplies are consumed and also replenished. Several categories of supply are distinguished[1]:

[1] Source: APP-6(C), NATO joint military symbology.

- **Class I –** Items which are consumed by personnel or animals at the approximately uniform rate, irrespective of local changes in combat or terrain conditions. Food is a typical example.
- **Class II –** Supplies for which allowances are established by tables of organisation and equipment.
- **Class III –** Petrol, oil and lubricants.
- **Class IV –** Supplies for which initial issue allowances are not prescribed by approved issue tables. Normally such supplies include fortification and construction materials, as well as additional quantities of items identical to those authorised for initial issue (Class II), such as additional vehicles.
- **Class V –** Ammunition, explosives and chemical agents of all types.

For tactical exercises mainly classes III and V are relevant:

- Class III supplies are not simulated, but the real materials are used in realistic quantities. There is no requirement for the training system to register or analyse the consumption and resupply of fuel.
- Class V supplies are simulated and it is required to register and analyse ammunition consumption and resupply.
- It is noted that medical treatment also consumes material, but there is no requirement to simulate such medical materials and thus there is no requirement for resupply.

Resupply activities that must be supported by the training system can be performed by:

- A resupply vehicle. Such a vehicle is equipped with specific types of ammo in certain quantities. A resupply activity will reduce the stock available for subsequent resupplies. In reality resupply of ammo will take (some) time, this must also be simulated.
- Members of EXCON, including O/Cs in the field. EXCON must have the possibility to initiate a resupply activity, either taking into account the resupply time it would take a resupply vehicle or instantaneously. For analytical and monitoring purposes it is useful to make a distinction between an instantaneous resupply activity and an EXCON reset of the (initial) supplies.

Resupply activities that can take place in reality, but need not to be supported by the training system:

- Resupply of blank ammunition. This ammunition exists in reality and can therefore be physically distributed without interaction with the training system. This applies for example to ammunition of small calibre weapons.
- Redistribution of supplies by the elements of a tactical unit amongst themselves. For example tank crews of a platoon redistributing shells within the platoon.
- Resupply in special resupply depots. Such large scale resupply in specific logistical areas can be performed by EXCON.

To enable the implementation of resupply of simulated ammunition, it is required that players can interact with a DO to request the current stock of simulated ammunition of that DO and, when authorised, to change the stock. How these interactions are physically implemented is not prescribed.

Table E-21: Logistic Engagement Dataset.

Parameter	Purpose	Unit	Max	Accuracy
Supplier DO ID	ENGAGING MONITORING	ID	15,000	–
Supplier DO location (x, y, z), plus accuracy indicator	ENGAGING MONITORING	Meter	World coordinate	Meter
Supply activity ID	EFFECT CALCULATION MONITORING	ID	100	–
Ammunition type	EFFECT CALCULATION MONITORING	Category		–
Supply quantity	EFFECT CALCULATION MONITORING	Number	10,000	1
Engagement time	MONITORING	Seconds		Second
Supply duration	EFFECT CALCULATION MONITORING	Number	3,600 (1 hour)	Second
Affected DO ID	ENGAGING MONITORING	ID		–
Affected DO location (x, y, z), plus accuracy indicator	ENGAGING MONITORING	Meter	World coordinate	Meter

Supplier DO ID

The ID of the DO that performs the resupply activity.

Supplier DO Location

The location of the supplying DO, mainly used for monitoring purposes, but conditions can be checked that the supplying DO must be and stay during the resupply activity in the direct vicinity of the supplied DO.

Supply Activity ID

The activity identification of the performed resupply activity. A distinction can be made between giving or taking supplies, resulting in a positive or negative value of the parameter.

Ammunition Type

The type of ammunition being resupplied. If more than one type of ammunition is supplied, then multiple engagements are required, one for each ammo type.

Supply Quantity

The amount of shells involved in the resupply activity.

Engagement Time

The instance in time when the resupply activity starts and is mainly used for monitoring purposes.

Supply Duration

The duration in seconds of how long the resupply activity will take to become in effect.

Affected DO ID

The ID of the DO to be resupplied.

Affected DO Location

The location of the DO to be resupplied.

E.11 O/C IMITATED ENGAGEMENTS

It is required that an O/C can interact with other DOs, as if he were a normal player, simulating their engagements. This capability is required for training purposes of the affected DO, within the context of the tactical training exercise. Examples of this situation are exposing the weak spots of an attack or defence, by simulating fire from a dug in enemy tank or an enemy sniper, or stepping in when the trainee interactions are not delivering the required results in the training context for whatever reasons (e.g., incapable trainees, system malfunctions).

If for "normal" E1 engagements the affected DO is notified who or what caused the interaction, in this case he will **not** be notified it was an O/C or EXCON interaction, but he will be provided with imitated information, such as for example the party of the shooter (e.g., BLUEFOR, REDFOR, NEUFOR) and the ammunition type. Since an O/C has no party (he is impartial) and should be able to simulate any type of weapon, he must specify these values before the engagement.

For monitoring purposes, the ID of the O/C will be part of the engagement to distinguish between O/C and other DO engagements. Although the O/C will simulate an engagement, operational conditions or restrictions regarding associated skills and drills (such as for example time, distance, speed of the shooter, accuracy etc.) will not apply, because it is not the objective to train the O/C, but to deliberately expose a DO to the engagement.

The tables below are derived from the engagement tables described in the previous paragraphs. Certain parameters have been omitted and only the additional O/C specific parameters are highlighted (in orange) and explained.

E.11.1 O/C Imitated Contact and Proximity Engagements

Table E-22: O/C Imitated Contact and Proximity Engagement Dataset (Including Missiles).

Parameter	Purpose	Unit	Max	Accuracy
O/C ID	MONITORING	ID	15,000	–
O/C location (x, y, z), plus accuracy indicator	TARGETING MONITORING	Meter	World coordinate	Sub-decimeter
Imitated party ID	MONITORING	Category		–

Parameter	Purpose	Unit	Max	Accuracy
Imitated weapon type	MONITORING	Category		–
Weapon direction/angle (vector), plus accuracy indicator	TARGETING			VERY HIGH
Imitated ammunition type	DAMAGE CALCULATION	Category		–
Duration of flight	TARGETING	Seconds		Micro-seconds
Engagement range	DAMAGE CALCULATION MONITORING	Meter		Meter
Detonation location (x, y, z), plus indicator of accuracy	DAMAGE CALCULATION MONITORING	Meter		Sub-decimeter
Effect direction/angle (vector) at the moment of detonation	DAMAGE CALCULATION			HIGH
Effect volume	DAMAGE CALCULATION	Meter		Meter
Terrain	TARGETING DAMAGE CALCULATION	Meter		Sub-decimeter
Affected DO(s) ID	DAMAGE CALCULATION	ID		–
Affected DO(s) location (x, y, z), plus accuracy indicator	TARGETING MONITORING	Meter	World coordinate	Sub-decimeter
Affected DO(s) velocity (vector), plus accuracy indicator	TARGETING MONITORING	Meter/sec		Meter
Time of start of the engagement (trigger time), plus accuracy indicator	TARGETING MONITORING	Seconds		Micro-second
Time of end of the engagement (impact time), plus accuracy indicator	TARGETING MONITORING	Seconds		Micro-second
Point of impact	DAMAGE CALCULATION	Meter		Sub-decimeter
Projectile impact velocity (vector), plus accuracy indicator	DAMAGE CALCULATION	Meter/sec		As required

Note that parameters such as O/C velocity, weapon ID, ammunition ID and atmospheric data are not part of the engagement dataset. This dataset also covers O/C imitated missile engagements (through the parameter “time of flight”). The other missile specific parameters (“designator” and “engagement validation”) are not applicable for the O/C imitated engagement.

O/C ID

The identification of the O/C that initiates the engagement.

O/C Location

The three-dimensional position of the O/C at the start of the engagement.

Imitated Party ID

The party of the imitated shooter. In normal DO engagements, the shooter ID will also give access to the party and the platform type of the shooter. This is not the case for an O/C engagement, therefore the O/C must specify this value before the engagement.

Imitated Weapon Type

The weapon type of the imitated shooter. In normal DO engagements, the weapon type is implicitly set by the shooter, based on the DO platform type and settings by the gunner (e.g., a main battle tank firing with the main gun or the coax machine gun). Since an O/C can simulate fire of any weapon type, the O/C must specify this value before the engagement.

Imitated Ammunition Type

The type of the imitated ammunition. Since an O/C can simulate fire of any weapon type, the O/C must specify this value before the engagement. The value of the imitated ammunition type should not be in conflict with the value of the imitated weapon type.

E.11.2 O/C Imitated Energy Weapon Engagements

Table E-23: O/C Imitated Energy Weapon Engagement Dataset.

Parameter	Purpose	Unit	Max	Accuracy
O/C ID	MONITORING	ID	15,000	–
O/C location (x, y, z), plus accuracy indicator	TARGETING MONITORING	Meter	World coordinate	Sub-decimeter
Imitated party ID	MONITORING	Category		–
Imitated weapon type	MONITORING	Category		–
Weapon direction/angle (vector), plus accuracy indicator	TARGETING			VERY HIGH
Imitated energy type	DAMAGE CALCULATION	Category		–
Imitated energy level	DAMAGE CALCULATION			–
Effect volume	DAMAGE CALCULATION	Meter		Meter

Parameter	Purpose	Unit	Max	Accuracy
Activation time	TARGETING MONITORING	Seconds		Second
Deactivation time	TARGETING MONITORING	Seconds		Second
Engagement time	MONITORING	Seconds		Second
Engagement duration	DAMAGE CALCULATION	Seconds		Second
Terrain	TARGETING DAMAGE CALCULATION	Meter		Sub-decimeter
Atmospheric data	TARGETING			–
Affected DO(s) ID	DAMAGE CALCULATION	ID		–
Affected DO(s) location (x, y, z), plus accuracy indicator	TARGETING MONITORING	Meter	World coordinate	Sub-decimeter
Affected DO(s) velocity (vector), plus accuracy indicator	TARGETING MONITORING	Meter/sec		Meter
Point of impact	DAMAGE CALCULATION	Meter		Sub-decimeter

O/C ID

The identification of the O/C that initiates the engagement.

O/C Location

The three-dimensional position of the O/C at the start of the engagement.

Imitated Party ID

The party of the imitated shooter, set by the O/C before the engagement.

Imitated Weapon Type

The type of the imitated energy weapon, set by the O/C before the engagement.

Imitated Energy Type

The type of the emitted energy, set by the O/C before the engagement.

Imitated Energy Level

The level of the emitted energy, set by the O/C before the engagement.

E.11.3 Other O/C Imitated Engagements

An O/C can also simulate the following engagements:

- Repair engagements;
- Medical engagements; and
- Logistic engagements.

The datasets for the O/C imitated engagements are exactly the same as the datasets for the respective activities of normal DOs, taking into account that the “O/C ID” and “O/C location” are replacing the respective “Repair DO”, “Medic DO” and “Supplier DO” parameters. Also certain conditions for the engagement to take effect do not need to apply, such as the O/C being and staying in the direct vicinity of the affected DO.

E.12 INTEGRATION WITH THE AIR DOMAIN

E.12.1 Airpower Example Situations

Urban operations are not exclusively the task for ground based forces, but urban operations are generally conducted by joint forces, incorporating aerial and naval forces.

Typical example situations from the air domain, related to urban operations, have been analysed in order to derive any possible additional requirements regarding the UCATT interfaces and the definition of the engagement data. The situations within an urban environment involving aerial entities can be categorised into the following tasks:

- **Close Air Support (CAS):** CAS is air action by fixed-wing and rotary-wing aircraft against hostile targets that are in close proximity to friendly forces, and requires detailed integration of each air mission with the fire and movement of those forces (JP3-09-3). Coordination is typically handled by specialists such as Joint Fires Observers, Joint Terminal Attack Controllers (JTAC), and Forward Air Controllers (FAC).
- **Close Combat Attack (CCA):** CCA is a hasty or deliberate attack by helicopters providing air-to-ground fires for friendly units engaged in close combat as part of the army combined arms team. Due to the close proximity of friendly forces, detailed integration is required. Due to capabilities of the aircraft and the enhanced situational awareness of the aircrews, terminal control from ground units or controllers is not necessary (US JP3-09-3).
- **Airmobile operation:** An airmobile operation is an operation in which combat forces and their equipment manoeuvre about the battlefield by aircraft to engage in ground combat (AAP-6, NATO Glossary of Term and Definitions).
- **Air Assault operation:** An air assault operation is an operation in which integrated helicopter, ground, combat support and combat service support forces manoeuvre and carry out combat, in and from the air.
- **Air Mechanised operation:** An air mechanised operation is an operation in which an aviation force, heavy in armed/attack helicopters, conducts independent combat and attacks from the air (AAP-6, NATO Glossary of Term and Definitions).
- **Para/Airborne operation:** An airborne operation is an operation involving the movement of combat forces and their logistic support into an objective area by air. An airborne deployment is carried out by troops specially trained to carry out operations, either by paradrop or air landing, following an air movement (AAP-6, NATO Glossary of Term and Definitions).
- **Casualty and Medical Evacuation (CASEVAC, MEDEVAC):** These missions involve extracting wounded personnel from the battlefield by helicopter. The medical helicopter does not engage other

DOs, but can be engaged by other DOs. The medical helicopter can be escorted by armed helicopters, which can engage and be engaged by other DOs.

- **Search and Rescue (SAR) and Combat Search and Rescue (CSAR):** SAR missions involve extracting personnel from the battlefield by helicopter, possibly under combat conditions. The helicopters can engage and be engaged by other DOs.
- **Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR):** The purpose is to gather information from the urban environment. This can be performed by either armed or unarmed entities.

In reality a distinction is to be made between manned and unmanned aerial systems. From the training system point of view, this distinction is irrelevant. Unarmed unmanned aerial systems are generally used for gathering or relaying information. They do not engage other DOs, but can be engaged by other DOs. Armed unmanned aerial systems however, can also serve as a delivery platform for ammunitions (bombs, missiles, bullets). Like manned aerial systems they can engage and be engaged by other DOs.

It is recognised that aerial entities can engage each other, but those related training objectives are considered outside the scope of urban operations live training systems.

E.12.2 Airpower Requirements

The example situations within an urban environment involving aerial entities are variations of either engaging other entities or transportation of personnel and materiel to and from the battlefield. Based on these example situations the following requirements can be derived:

1) The positions of the aerial entities need to be tracked, at least for monitoring purposes.

2) Armed aerial entities must be able to engage other entities. The priority from an urban point of view is on air to ground engagements, not on air to air engagements.

   Aerial engagements include:

   a) Contact and proximity engagements (covering direct fire weapons and bombs).
   b) Missiles.
   c) CBRN areas (created by bombs or by spraying from an aircraft).
   d) Minefields (aerial delivered mines).
   e) Energy weapons.

3) Aerial entities must be able to be engaged and change their status accordingly. The priority from an urban point is on ground to air engagements, not on air to air engagements.

4) Personnel must be able to mount and dismount (including rappelling and parachuting) from aerial transport entities. Personnel within the aerial entities that can operate independently from the aerial entity, should also be modelled as DOs. But for example pilots need not to be modelled as DOs and can be considered as integral part of the aerial system.

The conclusion is that aerial entities must be considered as DOs, with all associated properties and capabilities. The required interactions of aerial DOs with other DOs in the urban environment are covered by the datasets defined in the previous paragraphs.

E.13 INTEGRATION WITH THE NAVAL DOMAIN

E.13.1 Naval Use Cases

Naval forces can have an influence on urban operations when naval entities operate close to shore, within harbours, on rivers or on shore.

Typical example situations from the naval domain, related to urban operations, have been analysed in order to derive any possible additional requirements regarding the UCATT interfaces and the definition of the engagement data. The following naval tasks and effects are related to the urban environment:

- **Naval fire support:** Naval vessels can use their weapon systems to influence the entities and infrastructure within the urban environment. This includes direct fires, indirect fires and missiles.
- **Amphibious landing:** This is delivering marine troops from seaborne vessels to shore. It can be on a large scale, using landing boats and/or amphibious vehicles, but it also includes small scale special forces insertions.
- **Patrolling, surveillance and intelligence gathering:** Using seaborne platforms close to shore to capture for example visual and signal information.
- **Sea mines:** Naval vessels closing in on shore can be engaged by seaborne contact or influence mines, chancing the operational status and capabilities of those naval vessels. Training mine countermeasures by mine sweeping or mine hunting vessels is considered outside the scope of urban operations live training systems.

It is recognised that naval entities can engage each other, but those related training objectives are considered outside the scope of urban operations live training systems.

E.13.2 Naval Requirements

The example situations within an urban environment involving naval entities are variations of either engaging other entities or transportation of personnel and materiel to and from the shore. Based on these example situations the following requirements can be derived:

1) The positions of the naval entities need to be tracked, at least for monitoring purposes.

2) Armed naval entities must be able to engage other entities. The priority from an urban point of view is on sea to shore engagements, less on sea to sea engagements.

   Naval engagements include:

   a) Contact and proximity engagements (covering direct fire weapons, individual naval artillery shells and individual sea mines).
   b) Missiles.
   c) Sea mines (modelled as seaborne minefields).
   d) Fire support areas (naval artillery).
   e) CBRN areas.
   f) Energy weapons.

3) Naval entities must be able to be engaged and change their status accordingly. The priority from an urban point is on ground to sea engagements, less on sea to sea engagements.

4) Personnel must be able to embark on and debark from naval transport entities. Personnel within the naval entities that can operate independently from the naval entity (such as marine infantry), should also be modelled as DOs.

These requirements apply to naval entities that operate on the surface of the water (surface ships). Naval entities that operate above the surface are considered as aerial entities. Those requirements are covered by Section D.12.

Finally, naval entities that operate below the surface of the water (submersibles) are considered outside the scope of urban operations live training systems.

The conclusion is that (surface) naval entities must be considered as DOs, with all associated properties and capabilities. The required interactions of (surface) naval DOs with other DOs in the urban environment are covered by the datasets defined in the previous paragraphs.

Annex F – E4: DO REPORTING

F.1 INTRODUCTION

This annex contains the definition of the E4 dataset. E4 reports on the status, status changes and activities of a DO.

The following tables describe the content of the E4 interface. They contain one extra column, "priority", to guide the standardisation effort with a User point of view, to be combined with technical possibilities, in determining the extent of the first version of the UCATT E4 standard. The levels of priority for the parameter concerning the tactical outcome of the exercise, analysis of the exercise or administrative purposes or for future growth are defined below:

- Important for the tactical outcome of the exercise = 1.
- Important for analysis of the exercise = 2.
- Important for administrative purposes = 3.
- Not important for the first version of the UCATT E4 standard, but is intended for future growth = 4.

It is recognised that the need of a data element to be part of an interface (also) depends on the technical implementation of the training system (e.g., laser versus geo pairing). Currently the levels of priority are based on the importance of that parameter for the training staff, not the physical implementation.

Some data can be derived from other parameters, for example speed and direction can be derived from the velocity vector. If provided as two separate parameters, speed and direction can have different priorities. Also, if a higher level of parameter is not present in the dataset, a lower level parameter can become more important.

F.2 MONITOR DO STATUS

In the table below the data elements to monitor the status of DOs for exercise purposes are listed. In addition, for each data element a latency indication is provided. Latency is defined as the delay between an event occurring and the data of that event appearing in EXCON. It is a measure of how critical the current value of the data element is for monitoring and control purposes.

Update rate is the frequency of how often information is refreshed. For simplicity it is assumed that the update rate has the same order of magnitude as the latency.

These timings are divided into three categories:

- Real-time, and in effect this implies in fractions of a second.
- Near real-time, and in effect implies in seconds.
- Administrative time, is less time critical and implies a time longer than seconds.

Table F-1: DO Status Dataset.

Data Element	Latency	Priority
DO ID, the system identification of the DO	Near real-time	1
DO location	Real-time	1
DO velocity	Near real-time	2

Data Element	Latency	Priority
DO direction	Near real-time	1
DO orientation	Near real-time	1
DO articulation parameters. An articulated part of a DO is an element that can move relative to the main body of the DO	Near real-time	2
DO posture, e.g. standing, kneeling, laying	Near real-time	2
DO health or operational status ('kill codes')	Real-time	1
Equipment pairing	Near real-time	2
DO association	Near real-time	1
DO logistic/supplies state	Near real-time	2
DO additional status information	Near real-time	2

It is assumed that only the "DO ID" is part of the E4 dataset and that when required the parameters "DO call sign", "DO category", "DO type indication" and "DO force ID" are derived from this parameter.

The latency of DO location and DO status is low, because EXCON requires this information to trigger certain events or effects (for example to control targetry).

Changes in equipment pairing must be monitored. This applies for example to putting on/off body armour or a CBRN mask. This includes also picking up or putting down a weapon not modelled as a DO.

Changes in DO paring must be monitored. This applies for example to soldiers mounting a vehicle or entering a building and to a soldier picking up or putting down a weapon modelled as a DO.

"DO additional status information" covers other properties of a DO, typically properties of which status changes cannot be determined by engagements, DO association or equipment pairing, but are set and changed by EXCON or O/C interaction. An example is "Dug in", indicating that a DO is dug in and therefore has a reduced probability of being hit by for example artillery. Another example is wearing body armour, which is not sensed by the system, but must be provided by EXCON or O/C. Another example of this status information is "Prisoner status", indicating the DO is taken prisoner. This information is important for monitoring purposes, because when taken prisoner, events happening to him are in a different context (e.g. being wounded or killed). Another example is information resulting from engagements, such as detailed medical parameters not reflected in the operational status (e.g. heart rate or blood pressure). A third example is "Reinforced wall", applicable when the occupants of a house have strengthened a wall of the house, decreasing its vulnerability against certain ammunitions.

The parameter "DO additional status information" is not further specified at this moment, because it will only be part of the highest level of interoperability of UCATT and contains elements that will only be part of future systems.

F.3 MONITOR DO SYSTEM STATE

System management must be able to monitor the following data:

- Technical status of the training equipment;
- Battery status;

- BIT (built in test);
- Radio signal strength (when applicable);
- Connectivity of system components (e.g., is the datalink operational?); and
- Cheating signal (e.g., remove a cable).

F.4 DO STATUS CHANGE

The dataset of elements to monitor status changes of DOs is shown in Table F-2.

Table F-2: DO Status Change Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Affected DO ID	MONITORING	ID		–	1
Affected DO location (x, y, z), plus accuracy indicator	MONITORING	Meter	World coordinate	Meter	1
Affected DO(s) velocity, plus accuracy indicator	MONITORING	Meter/sec		Meter	1
Event time	MONITORING	Seconds		1 second	1
Event type ID	MONITORING	ID	100	–	1
Event parameters	MONITORING	Number	10,000	1	1
Causing DO ID	MONITORING	ID	15,000	–	1

Event Time

The instance in time when the status change occurs.

It is possible that given the combination of “Affected DO ID” and “Interaction time” the properties of the affected DO, such as “Affected DO location” and “Affected DO velocity” can be derived from other sources.

Event Type ID

The identification of the type of event that caused the status change. This includes:

- Contact and proximity engagements.
- Missile engagements.
- Area engagements.
- Repair and medical activities.
- O/C interactions.
- Time driven events, caused by lack of activities, for example the health of a wounded soldier who is not treated can degrade over time.
- Tampering activities of the trainees.

Event Parameters

The relevant parameters that are associated with the “Event ID”. These parameters are a subset of the data elements specified in the respective engagements.

Causing DO ID

The ID of the DO that caused the status change of the affected DO. It can be a “normal” DO, an O/C, EXCON or it can be not applicable if the status change is the result of time driven processes.

F.5 ENGAGEMENTS

F.5.1 Contact and Proximity Engagements

Table F-3: Engagement Reporting Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Shooter ID	MONITORING	ID	100,000	–	1
Shooter location (x, y, z), plus accuracy indicator	TARGETING MONITORING	Meter	World wide	Sub-decimeter	1
Shooter velocity (vector), plus accuracy indicator	TARGETING MONITORING	Meter/sec		Meter	1
Weapon type	TARGETING MONITORING	Category		–	1
Weapon ID	ANALYSIS	ID	100	–	3
Shooter weapon mode	TARGETING MONITORING	Category			2
Weapon direction/angle (vector), plus accuracy indicator	TARGETING			VERY HIGH	4
Ammunition type	DAMAGE CALCULATION MONITORING	Category			2
Fuse type	TARGETING MONITORING	Category			2
Fuse settings	TARGETING MONITORING				2
Engagement range	DAMAGE CALCULATION MONITORING	Meter		Meter	1
Detonation location (x, y, z), plus indicator of accuracy	DAMAGE CALCULATION MONITORING	Meter		Sub-decimeter	1
Effect direction/angle (vector) at the moment of detonation	DAMAGE CALCULATION MONITORING			HIGH	2

Parameter	Purpose	Unit	Max	Accuracy	Prio
Projectile impact velocity (vector), plus accuracy indicator	DAMAGE CALCULATION	Meter/sec		As required	4
Effect volume (visualise to explain the results to the trainees)	DAMAGE CALCULATION MONITORING	Meter		Meter	2
Terrain	TARGETING DAMAGE CALCULATION	Meter		Sub-decimeter	4
Atmospheric data	TARGETING				4
Affected DO(s) ID	DAMAGE CALCULATION MONITORING	ID			1
Affected DO(s) location (x, y, z), plus accuracy indicator	TARGETING MONITORING	Meter	World coordinate	Sub-decimeter	1
Affected DO(s) velocity (vector), plus accuracy indicator	TARGETING MONITORING	Meter/sec		Meter	1
Time of start of the engagement (trigger time), plus accuracy indicator	TARGETING MONITORING	Seconds		Micro-second	1
Time of end of the engagement (impact time), plus accuracy indicator	TARGETING MONITORING	Seconds		Micro-second	1
Point of impact	DAMAGE CALCULATION	Meter		Sub-decimeter	2

F.5.2 O/C Imitated Contact and Proximity Engagements

In addition to the dataset for "normal" contact and proximity engagements, the following parameters must be implemented for engagements imitated by O/Cs.

Table F-4: O/C Engagement Reporting Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
O/C ID	MONITORING	ID	15,000	–	1
O/C location (x, y, z), plus accuracy indicator	TARGETING MONITORING	Meter	World coordinate	Sub-decimeter	1
Imitated party ID	MONITORING	Category		–	1
Imitated weapon type	MONITORING	Category		–	1
Imitated ammunition type	DAMAGE CALCULATION	Category			1

F.5.3 Missile Engagements

In addition to the dataset for contact and proximity engagements, the following parameters must be implemented for missile engagements.

Table F-5: Missile Engagement Reporting Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Designator ID	TARGETING MONITORING	ID	15,000	–	1
Designator location (x, y, z), plus accuracy indicator	TARGETING MONITORING	Meter	World coordinate	Sub-decimeter	1
Designator velocity (vector), plus accuracy indicator	TARGETING MONITORING	Meter/sec		Meter	2
Duration of flight	TARGETING	Seconds		Micro-seconds	4
Engagement validation	TARGETING	YES/NO			2

F.6 MINEFIELDS

When minefields are centrally managed by EXCON, E4 will not be involved in any data transfer regarding these minefields. Creation and deactivation of minefields will typically be reported to other training systems through E8 and results of engagements with minefields is sent through E3.

However, when a DO is capable of creating and deactivating minefields, (the results of) these activities must be reported to EXCON. This is done through E4. Also when a DO is capable of detecting entering and engaging with a minefield, E4 is required.

F.6.1 Minefield Creation

Table F-6: Minefield Creation Reporting Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Minefield ID	MONITORING	ID		–	1
Emplacer ID	MONITORING	ID	15,000	–	1
Mine IDs (in case of individual virtual mines)					3
Minefield location	TARGETING	Meter	1,000	Sub-decimeter	1
Ammunition type(s)	DAMAGE CALCULATION	Category		–	1
Ammunition type density	TARGETING	Mines/m^2		0.01	1
Activation time	TARGETING	Seconds		1 second	1

F.6.2 Minefield Deactivation

Table F-7: Minefield Deactivation Reporting Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Minefield ID	MONITORING	ID		–	1
Deactivation time	TARGETING	Seconds		1 second	1

This dataset is only relevant when a minefield is a DO itself. When it only exists in EXCON, there is no need for E4 interaction. For external communication E8 would suffice.

F.6.3 Minefield Engagements

This dataset is only relevant when a minefield is a DO itself and/or a DO can detect when he enters a minefield.

Table F-8: Minefield Engagement Reporting Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Minefield ID	MONITORING	ID		–	1
Engagement time	MONITORING	Seconds		1 second	1
Terrain	TARGETING DAMAGE CALCULATION			–	4
Affected DO(s) ID	DAMAGE CALCULATION	ID		–	1
Affected DO(s) location	DAMAGE CALCULATION	Meter		–	1

F.6.4 Clearing of Mines and Minefields

This dataset is only relevant for E4 when a DO is capable of interacting with a minefield, such as clearing mines or creating breaching lanes through a minefield.

Table F-9: Clearing of Mines and Minefields Reporting Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Operator ID	TARGETING	ID	15,000		1
Mine or Minefield ID	MONITORING	ID		–	1
Activity	DAMAGE CALCULATION	Category		–	2
Time of start of the engagement	TARGETING MONITORING	Seconds		1 second	1

Parameter	Purpose	Unit	Max	Accuracy	Prio
Time of end of the engagement	TARGETING MONITORING	Seconds		1 second	1
Breach lane location	TARGETING	Meter	1,000	Sub-decimeter	1

A DO can completely remove a minefield or can create breaching lanes, over which a safe passage is possible. The creation of a breaching lane through a minefield requires an additional parameter.

Breach Lane Location

This is a polygon describing a passage through a minefield. Depending on the implementation this can be a parameter of a minefield or a separate object. Typically a breach lane starts and ends before the borders of a minefield.

F.7 FIRE SUPPORT TARGET AREAS

In many current live training systems, (ground based) fire support is not simulated by live fire support DOs, but the effects of fire support are generated, for example by fire support target areas created by EXCON.

However, it is envisioned that fire support entities can also be part of live training exercises, like for example mortars, howitzers and rocket launching systems. In that case, those DOs cannot engage their targets in a direct way and often their targets are beyond their line of sight. Fire support engagements with live fire support DOs then require two stages. In the first stage, the fire support DOs must report their firing activities to another part of the training system (typically EXCON). These reports are part of E4. In the second stage the training system delivers the fire support engagement to the affected DO(s). This is part of E3.

Table F-10: Fire Support Reporting Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Shooter ID	MONITORING	ID	100,000	–	1
Shooter location (x, y, z), plus accuracy indicator	TARGETING MONITORING	Meter	World wide	Sub-decimeter	1
Shooter velocity (vector), plus accuracy indicator	TARGETING MONITORING	Meter/sec		Meter	1
Weapon type	TARGETING MONITORING	Category		–	1
Weapon ID	ANALYSIS	ID	100	–	3
Shooter weapon mode	TARGETING MONITORING	Category			2
Weapon direction/angle (vector), plus accuracy indicator	TARGETING			VERY HIGH	4

Parameter	Purpose	Unit	Max	Accuracy	Prio
Ammunition type (incl charge)	DAMAGE CALCULATION MONITORING	Category			2
Fuse type	TARGETING MONITORING	Category			2
Fuse settings	TARGETING MONITORING				2

This dataset for reporting a firing event by a fire support DO is a subset of the direct and proximity engagement dataset.

An important parameter is the charge with which an ammunition is fired, because it determines the ballistic trajectory, and thus the impact location. It is assumed that the charge is part of the "Ammunition type", otherwise a new parameter "Charge" is required.

F.8 CBRN AREAS

Like minefields, when CBRN areas are centrally managed by EXCON, E4 will not be involved in any data transfer regarding these CBRN areas. But when a DO is capable of creating and deactivating CBRN areas, and detecting entering and engaging with a CBRN area, reporting (the results of) these activities through E4 is required.

F.8.1 CBRN Area Creation

Table F-11: CBRN Area Creation Reporting Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
CBRN area ID	MONITORING	ID		–	1
Shooter ID	MONITORING	ID	15,000	–	1
CBRN area location	TARGETING	Meter		Meter	1
CBRN area shape	TARGETING	Meter	10,000	Meter	1
Agent type	DAMAGE CALCULATION	Category		–	1
Agent density	DAMAGE CALCULATION	ppm		1	1
Activation time	TARGETING	Seconds		1 second	1

F.8.2 CBRN Area Deactivation

Table F-12: CBRN Area Deactivation Reporting Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
CBRN area ID	MONITORING	ID		–	1
Deactivation time	TARGETING	Seconds		1 second	1

F.8.3 CBRN Area Engagements

Table F-13: CBRN Area Engagement Reporting Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
CBRN area ID	MONITORING	ID		–	1
Engagement time	MONITORING	Seconds		1 second	1
Engagement duration	DAMAGE CALCULATION	Seconds		1 second	1
Affected DO(s) ID	DAMAGE CALCULATION	ID		–	1
Affected DO(s) location	DAMAGE CALCULATION	Meter		–	1

F.8.4 CBRN Decontamination Area Creation

Table F-14: CBRN Decontamination Area Creation Reporting Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Decontamination area ID	MONITORING	ID		–	1
Shooter ID	MONITORING	ID	15,000	–	1
Decontamination area location	TARGETING	Meter	1,000	Meter	1
Activation time	TARGETING	Seconds		1 second	1

F.8.5 CBRN Decontamination Area Deactivation

Table F-15: CBRN Decontamination Area Deactivation Reporting Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Decontamination area ID	MONITORING	ID		–	1
Deactivation time	TARGETING	Seconds		1 second	1

F.8.6 CBRN Decontamination Area Engagements

Table F-16: CBRN Decontamination Area Engagement Reporting Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Decontamination area ID	MONITORING	ID		–	1
Engagement time	MONITORING	Seconds		1 second	1
Engagement duration	DAMAGE CALCULATION	Seconds		1 second	1
Affected DO(s) ID	DAMAGE CALCULATION	ID		–	1
Affected DO(s) location	DAMAGE CALCULATION	Meter		–	1

F.9 ENERGY WEAPONS ENGAGEMENTS

F.9.1 Energy Weapon Employment

Table F-17: Energy Weapon Employment Reporting Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Shooter ID	MONITORING	ID	15,000	–	1
Shooter location (x, y, z), plus accuracy indicator	TARGETING MONITORING	Meter	World coordinate	Sub-decimeter	1
Shooter velocity (vector), plus accuracy indicator	TARGETING MONITORING	Meter/sec		Meter	1
Weapon type	MONITORING	Category		–	1
Weapon ID	ANALYSIS	ID		–	3
Shooter weapon mode	TARGETING MONITORING	Category			2
Weapon direction/angle (vector), plus accuracy indicator	TARGETING			+/- 10% compared to actual weapon	4
Energy type	DAMAGE CALCULATION	Category			1
Energy level	DAMAGE CALCULATION				1
Effect volume (visualise to explain the results to the trainees)	DAMAGE CALCULATION	Meter		Meter	2
Activation time	TARGETING MONITORING	Seconds		1 second	1

Since many of the parameters of employing an energy weapon can change during the employment, e.g. shooter position, energy level, effect volume etc., these changes must be reported when applicable. There is not only one start report and one end report.

F.9.2 Energy Weapon Engagements

Table F-18: Energy Weapon Engagement Reporting Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Shooter ID	MONITORING	ID	15,000	–	1
Shooter location (x, y, z), plus accuracy indicator	TARGETING MONITORING	Meter	World coordinate	Sub-decimeter	1
Shooter velocity (vector), plus accuracy indicator	TARGETING MONITORING	Meter/sec		Meter	1
Weapon type	MONITORING	Category		–	1
Weapon ID	ANALYSIS	ID		–	3
Shooter weapon mode	TARGETING MONITORING	Category			2
Weapon direction/angle (vector), plus accuracy indicator	TARGETING			+/- 10% compared to actual weapon	4
Energy type	DAMAGE CALCULATION	Category			1
Energy level	DAMAGE CALCULATION				1
Engagement time	MONITORING	Seconds		1 second	1
Engagement duration	DAMAGE CALCULATION	Seconds		1 second	1
Affected DO(s) ID	DAMAGE CALCULATION	ID			1
Affected DO(s) location (x, y, z), plus accuracy indicator	TARGETING MONITORING	Meter	World coordinate	Sub-decimeter	1
	TARGETING MONITORING	Meter/sec		Meter	1
Point of impact	DAMAGE CALCULATION	Meter		Sub-decimeter	2

F.9.3 O/C Imitated Energy Weapon Engagements

In addition to the dataset for "normal" energy weapon engagements, the following parameters must be implemented for energy weapon engagements imitated by O/Cs.

Table F-19: O/C Imitated Energy Weapon Engagement Reporting Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
O/C ID	MONITORING	ID	15,000	–	1
O/C location (x, y, z), plus accuracy indicator	TARGETING MONITORING	Meter	World coordinate	Sub-decimeter	1
Imitated party ID	MONITORING	Category		–	1
Imitated weapon type	MONITORING	Category		–	1
Imitated energy type	DAMAGE CALCULATION	Category			1
Imitated energy level	DAMAGE CALCULATION				1

F.10 JAMMERS

F.10.1 Jammer Activation

A DO (the "Carrier") must report when he makes activate (switches on) or changes the mode of a jammer.

Table F-20: Jammer Activation Reporting Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Carrier ID	MONITORING	ID	15,000	–	1
Jammer ID	MONITORING	ID		–	1
Jammer volume	TARGETING	Meter	1,000	Meter	1
Jammer frequency list	DAMAGE CALCULATION	Hz		–	1
Jamming mode	TARGETING MONITORING				1
Activation time	TARGETING MONITORING	Seconds		1 second	1

F.10.2 Jammer Deactivation

A DO (the "Carrier") must report when he deactivates (switches off) a jammer.

Table F-21: Jammer Deactivation Reporting Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Carrier ID	MONITORING	ID	15,000	–	1
Jammer ID	MONITORING	ID		–	1
Deactivation time	TARGETING	Seconds		1 second	1

F.10.3 Jammer Engagements

A DO (the "Affected DO") must be reported when he is influenced by a jammer, employed by another DO (the "Carrier").

Table F-22: Jammer Engagement Reporting Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Carrier ID	MONITORING	ID	15,000	–	1
Jammer ID	MONITORING	ID		–	1
Affected DO(s) ID	DAMAGE CALCULATION	ID		–	1
Affected DO(s) location	DAMAGE CALCULATION	Meter		–	1

F.11 REPAIR ACTIVITIES

Table F-23: Repair Activity Reporting Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Repair DO ID	ENGAGING MONITORING	ID	15,000	–	1
Repair DO location (x, y, z), plus accuracy indicator	ENGAGING MONITORING	Meter	World coordinate	Meter	1
Repair activity ID	EFFECT CALCULATION MONITORING	ID	100	–	1
Engagement time	MONITORING	Seconds		1 second	1
Repair duration	EFFECT CALCULATION MONITORING	Number	43,200 seconds (12 hours)	Second	2
Affected DO ID	ENGAGING MONITORING	ID		–	1
Affected DO location (x, y, z), plus accuracy indicator	ENGAGING MONITORING	Meter	World coordinate	Meter	1

F.12 MEDICAL ENGAGEMENTS

Table F-24: Medical Treatment Reporting Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Medic DO ID	ENGAGING MONITORING	ID	15,000	–	1

Parameter	Purpose	Unit	Max	Accuracy	Prio
Medic DO location (x, y, z), plus accuracy indicator	ENGAGING MONITORING	Meter	World coordinate	Meter	1
Medical activity ID	EFFECT CALCULATION MONITORING	ID	100	–	1
Engagement time	MONITORING	Seconds		1 second	1
Treatment duration	EFFECT CALCULATION MONITORING	Number	43,200 seconds (12 hours)	Second	1
Affected DO ID	ENGAGING MONITORING	ID		–	1
Affected DO location (x, y, z), plus accuracy indicator	ENGAGING MONITORING	Meter	World coordinate	Meter	1

F.13 LOGISTIC ENGAGEMENTS

Table F-25: Logistic Activity Reporting Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Supplier DO ID	ENGAGING MONITORING	ID	15,000	–	1
Supplier DO location (x, y, z), plus accuracy indicator	ENGAGING MONITORING	Meter	World coordinate	Meter	1
Supply activity ID	EFFECT CALCULATION MONITORING	ID	100	–	1
Ammunition type	EFFECT CALCULATION MONITORING	Category			1
Supply quantity	EFFECT CALCULATION MONITORING	Number	10,000	1	1
Engagement time	MONITORING	Seconds		1 second	1
Supply duration	EFFECT CALCULATION MONITORING	Number	3,600 (1 hour)	Second	2
Affected DO ID	ENGAGING MONITORING	ID		–	1
Affected DO location (x, y, z), plus accuracy indicator	ENGAGING MONITORING	Meter	World coordinate	Meter	1

Annex G – E2: TRAINING SYSTEM STATUS CHANGE

This annex contains the definition of the E2 dataset, the interface that controls the technical status of a training system and its components. Through this interface it is possible that a DO is initialised, reset, calibrated etc., and it accommodates the distribution of an (altered) terrain representation or damage models for systems that require this data at decentralised nodes.

Table G-1: DO Status Change.

Data Element	Latency
Setting the DO ID, the system identification of a DO	Near real-time
Setting the equipment ID for components not modelled as DO	Near real-time
Turning a DO on and off	Near real-time
Resetting a DO	Near real-time
Requesting a BITE response	Near real-time
Providing a DO with A-GPS data to enable it to fast acquire the GPS signal	Near real-time
Providing D-GPS data to increase the accuracy of the DO position	Near real-time

Table G-2: System Data Change.

Data Element	Latency
Configuration of the system state	Near real-time
ORBAT definitions (in part or as a whole)	Near real-time
Terrain data and damage model data. This can be the data itself, or a trigger to load/use the appropriate data	Near real-time
Weather data, to enable (decentralised) DOs to simulate behaviour of CBRN areas	Near real-time

Annex H – E3: DO STATUS CHANGE

H.1 INTRODUCTION

This annex contains the definition of the E3 interface, that sets the (simulated) operational status of a DO, either as a direct action of an O/C or from EXCON, to distribute the outcome of an engagement that is centrally evaluated or to distribute characteristics of engagement areas and engagement parameters in order to determine engagements and/or outcomes of engagements at the DO level respectively.

The following tables describe the content of the E3 interface. They contain a column, “priority”, to guide the standardisation effort with a user’s point of view, to be combined with technical possibilities, in determining the extent of the first version of the UCATT E3 standard. The levels of priority of two types: need to have or nice to have:

- Need to have – where the parameter is required for the tactical outcome of the exercise = 1.
- Nice to have – where the parameter is required for additional purposes = 2.

H.2 O/C INTERACTIONS

The O/C is a member of EXCON who is present in the simulated battlefield and therefore is also regarded as a DO. The O/C interactions can be divided into two categories, namely interactions that are specific to an O/C (EXCON) and that change the status of a DO directly. These interactions are part of the external interface E3. Secondly, an O/C must be able to execute or “imitate” the engagements of normal DOs. These imitated interactions are part of the E1 interface.

With these interactions an O/C can control the status of a DO, by (re)setting the value of a particular variable. Generally this is done as an exercise intervention outside the tactical training exercise context. For example, to reset a DO either because of a malfunction of the training equipment or just to let him continue the fight for training purposes. If the affected DO is notified who caused the interaction, he will be notified it was an O/C or EXCON interaction.

Table H-1: O/C Control Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Causing DO ID	ENGAGING MONITORING	ID	15,000	–	2
O/C location (x, y, z), plus accuracy indicator	MONITORING	Meter	World coordinate	Meter	1
Affected DO ID	ENGAGING MONITORING	ID		–	1
Affected DO location (x, y, z), plus accuracy indicator	MONITORING	Meter	World coordinate	Meter	1
Interaction time	MONITORING	Seconds		1 second	1
Interaction type ID	EFFECT CALCULATION MONITORING	ID	100	–	1

Parameter	Purpose	Unit	Max	Accuracy	Prio
Variable to be changed	EFFECT CALCULATION MONITORING	–	–	–	1
New value	EFFECT CALCULATION MONITORING	Number	10,000	1	1

Causing DO ID

The ID of the DO that caused the status change of the affected DO. It can be a virtual DO, an O/C or EXCON. This parameter is listed as part of this dataset to provide the relevant data across training systems. For example, when EXCON of system A changes the status of a DO of system B, system B needs to know the source and reason of the status change.

There is an alternative to provide this type on information though. Since the source of the status change is EXCON of system A, this information can be provided to system B through E8 (EXCON to EXCON), but that is a different solution.

O/C Location

The location of the O/C, used for monitoring purposes.

Affected DO ID

The ID of the DO that is interacted with. In some implementations this parameter could be omitted, since the affected DO is the receiver of this data message.

Affected DO Location

The location of the DO that is interacted with.

Interaction Time

The instance in time when the interaction occurs, used for monitoring purposes.

Interaction Type ID

This is information that indicates to the DO the reason for the status change, for example a reset by an O/C or being engaged by a weapon or ammunition. This parameter can trigger a message (e.g., a standardised audio sound such as an explosion or text) on the DO to inform the trainee.

Variable to Be Changed

The identification of variable to be changed, or a total reset of all variables. Exercise management must be able to set or change the following parameters:

- DO call sign.
- DO category.
- DO type.
- DO force ID.

- DO health or operational status ("damage status").
- DO logistic/supplies state.
- DO location. When a DO has its own capabilities to determine its location, there is generally no need to set its location from EXCON. Overriding the location of such a DO could possibly result in erroneous behaviour of the training system. However, when a DO (temporarily) has no access to its position (e.g., indoor), EXCON can provide its position. Another example is a mine or IED device, which has no capability to determine its location by itself, but when placed, is provided its location from EXCON or an O/C.
- DO association. Normally, DO association must be performed automatically by the training system. However, if relevant DOs have no capability to associate with each other (E9), e.g., a vehicle entering a house, but the association is important for the outcome of the tactical exercise (in this example the vehicle is protected by the infrastructure and it allows propagation of engagements and of effects), then the association can be given by EXCON through E3. This can either be an automatic function (for example, when the systems detects the locations of the DOs are the same) or can be done manually.
- DO additional status information.

In addition to the above defined capabilities, the training system must have a broadcast capability to trigger recorded audio messages to all DO, e.g., for emergency situations to stop the exercise. The list of recorded messages needs to be standardised.

New Value

The new value to which the specified variable will be set.

H.3 ENGAGEMENTS

First of all, the E3 datasets includes the complete E1 dataset, to enable that engagements can be triggered centrally but that the outcome is determined by the affected DOs (see Annex E).

Secondly, it is possible through E3 to provide only the outcome of engagements to the affected DOs, relevant when the outcomes of engagements are centrally determined. These outcomes may for example affect the operational status of a DO or it logistic supplies.

Table H-2: Control DO Variables Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Causing DO ID	MONITORING	ID	15,000	–	2
Affected DO ID	DAMAGE CALCULATION	ID	15,000	–	1
Variable to be changed	EFFECT CALCULATION	–	–	–	1
New value	EFFECT CALCULATION	Number	10,000	1	1
Engagement time	DAMAGE CALCULATION	Seconds		Micro-second	1

For results of certain engagements more data can be required to provide to the affected DO than just the new status and cause. Information regarding for example type of ammunition, distance and direction with respect to the DO can be important to generate the appropriate messages or effects. Also the detonation location can result in different types of explosions, e.g. air burst versus ground explosions, which can be represented by different visual representations in the field, so the trainees can learn from it and take the proper measures.

Table H-3: Control Contact and Proximity Engagement Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Causing DO ID	MONITORING	ID	15,000	–	2
Affected DO ID	DAMAGE CALCULATION	ID	15,000	–	1
Variable to be changed	EFFECT CALCULATION	–	–	–	1
New value	EFFECT CALCULATION	Number	10,000	1	1
Engagement time	DAMAGE CALCULATION	Seconds		Micro-second	1
Ammunition type	DAMAGE CALCULATION MONITORING	Category			1
Engagement range	DAMAGE CALCULATION MONITORING	Meter		Meter	1
Detonation location (x, y, z), plus indicator of accuracy	DAMAGE CALCULATION MONITORING	Meter		Sub-decimeter	1
Effect direction/angle (vector) at the moment of detonation	DAMAGE CALCULATION MONITORING			HIGH	1

H.4 MINEFIELDS

The distribution of the characteristics of minefields is required to enable DOs to determine engagements and resulting outcomes locally.

H.4.1 Minefield Creation

Table H-4: Minefield Creation Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Minefield ID	MONITORING	ID		–	1
Mine IDs (in case of individual virtual mines)					2

Parameter	Purpose	Unit	Max	Accuracy	Prio
Minefield location	TARGETING	Meter	1,000	Sub-decimeter	1
Mine locations (in case of individual virtual mines)	TARGETING	Meter	1,000	Sub-decimeter	1
Ammunition type(s)	DAMAGE CALCULATION	Category		–	1
Ammunition type density	TARGETING	Mines/m^2		0.01	1
Activation time	TARGETING	Seconds		1 second	1

H.4.2 Minefield Deactivation

Table H-5: Minefield Deactivation Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Minefield ID	MONITORING	ID		–	1
Deactivation time	TARGETING	Seconds		1 second	1

H.4.3 Minefield Engagements

There is no specific dataset required for minefield engagements. In case a DO determines engagements with a minefield by itself, the information is provided with the "minefield creation dataset". If a DO is only provided with the mine or ammunition type that is involved in the engagement, it is communicated through the "control contact and proximity engagement dataset".

H.4.4 Clearing of Mines and Minefields

Table H-6: Clearing of Mines and Minefields Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Minefield ID	MONITORING	ID		–	1
Breach lane	TARGETING	Meter	1,000	Sub-decimeter	1

When a minefield is breached, one or more lanes can be created over which a safe passage is possible and these must be known to DOs. This requires the parameter of the breach lane.

H.5 FIRE SUPPORT TARGET AREAS

Information regarding (definition of) fire support target areas needs to be provided through E3, when DOs are responsible for determining engagements with these areas. When a DO is only provided with the ammunition type that is involved in the engagement, it is communicated through the "control contact and proximity engagement dataset".

Table H-7: Fire Support Target Area Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Fire support target area location	TARGETING	Meter		Meter	1
Fire support target area shape	TARGETING	Meter	1,000	Meter	1
Ammunition type	DAMAGE CALCULATION	Category		–	1
Fuse type	TARGETING MONITORING	Category			1
Fuse settings	TARGETING MONITORING				1
Number of received salvos	TARGETING	Integer		1	1
Ammunition rounds per received salvo	TARGETING	Rounds/ salvo		1	1
Angle of impact	DAMAGE CALCULATION				1
Activation time	TARGETING	Seconds		1 second	1
Deactivation time	TARGETING	Seconds		1 second	1

H.6 CBRN AREAS

H.6.1 CBRN Area Creation

Table H-8: CBRN Area Creation Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
CBRN area ID	MONITORING	ID		–	1
Shooter ID	MONITORING	ID	15,000	–	1
CBRN area location	TARGETING	Meter		Meter	1
CBRN area shape	TARGETING	Meter	10,000	Meter	1
Agent type	DAMAGE CALCULATION	Category		–	1
Agent density	DAMAGE CALCULATION	ppm		1	1
Activation time	TARGETING	Seconds		1 second	1

H.6.2 CBRN Area Deactivation

Table H-9: CBRN Area Deactivation Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
CBRN area ID	MONITORING	ID		–	1
Deactivation time	TARGETING	Seconds		1 second	1

H.6.3 CBRN Area Engagements

In case a DO determines engagements with a CBRN area by itself, the information is provided with the “CBRN area creation dataset”. If a DO must determine the results of exposure to CBRN agents, this information is passed through the following dataset, as presented in Table H-10.

Table H-10: CBRN Engagement Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Affected DO ID	DAMAGE CALCULATION	ID	15,000	–	1
Agent type	DAMAGE CALCULATION	Category		–	1
Agent density	DAMAGE CALCULATION	ppm		1	1
Engagement time	DAMAGE CALCULATION	Seconds		1 second	1
Engagement duration	DAMAGE CALCULATION	Seconds		1 second	1

H.6.4 CBRN Decontamination Area Creation

Table H-11: CBRN Decontamination Area Creation Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Decontamination area ID	MONITORING	ID		–	1
Shooter ID	MONITORING	ID	15,000	–	1
Decontamination area location	TARGETING	Meter	1,000	Meter	1
Activation time	TARGETING	Seconds		1 second	1

H.6.5 CBRN Decontamination Area Deactivation

Table H-12: CBRN Decontamination Area Deactivation Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Decontamination area ID	MONITORING	ID		–	1
Deactivation time	TARGETING	Seconds		1 second	1

H.6.6 CBRN Decontamination Area Engagements

Table H-13: CBRN Decontamination Area Engagement Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Affected DO ID	DAMAGE CALCULATION	ID	15,000	–	1
Engagement time	DAMAGE CALCULATION	Seconds		Micro-second	1
Engagement duration	DAMAGE CALCULATION	Seconds		1 second	1

H.7 ENERGY WEAPONS ENGAGEMENTS

The following dataset is required when EXCON determines engagements with energy weapons, but the affected DO is responsible for the damage calculation.

Table H-14: Energy Weapon Engagement Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Affected DO ID	DAMAGE CALCULATION	ID	15,000	–	1
Energy type	DAMAGE CALCULATION	Category			1
Energy level	DAMAGE CALCULATION				1
Effect volume	DAMAGE CALCULATION	Meter		Meter	1
Engagement time	DAMAGE CALCULATION	Seconds		Micro-second	1
Engagement duration	DAMAGE CALCULATION	Seconds		1 second	1

H.8 REPAIR ACTIVITIES

Typically when EXCON executes repair activities, it is sufficient that the affected DO is provided with the new status, as defined in the basic E3 dataset "Control DO operational status dataset".

However, it can be envisioned that either non-instrumented mechanics or virtual mechanics in the training environment can perform repair activities. In both cases the repair activity must be initiated by EXCON.

Table H-15: Repair Activity Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Affected DO ID	ENGAGING MONITORING	ID	15,000	–	1
Repair activity ID	EFFECT CALCULATION MONITORING	ID	100	–	1
Engagement time	DAMAGE CALCULATION	Seconds		1 second	1
Repair duration	EFFECT CALCULATION MONITORING	Number	43,200 seconds (12 hours)	Second	1

H.9 MEDICAL ENGAGEMENTS

Like repair activities performed by EXCON, it is generally sufficient that the affected DO is provided with the new status, as defined in the basic E3 dataset "Control DO operational status dataset". But when non-instrumented or virtual medics can treat wounded personnel, the activity must be initiated by EXCON through E3.

Table H-16: Medical Engagement Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Affected DO ID	ENGAGING MONITORING	ID	15,000	–	1
Medical activity ID	EFFECT CALCULATION MONITORING	ID	100	–	1
Engagement time	DAMAGE CALCULATION	Seconds		1 second	1
Treatment duration	EFFECT CALCULATION MONITORING	Number	43,200 seconds (12 hours)	Second	1

H.10 LOGISTIC ENGAGEMENTS

The dataset for logistic engagements is only required when a logistic process must be simulated, that will last for a certain amount of time. Otherwise the basic E3 dataset to change the relevant parameters is sufficient.

Table H-17: Logistic Engagement Dataset.

Parameter	Purpose	Unit	Max	Accuracy	Prio
Affected DO ID	ENGAGING MONITORING	ID	15,000	–	1
Supply activity ID	EFFECT CALCULATION MONITORING	ID	100	–	1
Ammunition type	EFFECT CALCULATION MONITORING	Category			1
Supply quantity	EFFECT CALCULATION MONITORING	Number	10,000	1	1
Engagement time	MONITORING	Seconds		1 second	1
Supply duration	EFFECT CALCULATION MONITORING	Number	3,600 (1 hour)	Second	2

Annex I – EXAMPLES OF VIRTUAL, CONSTRUCTIVE AND LIVE SIMULATION INTEGRATION

This annex describes some examples of virtual and constructive simulation integration with the live domain, provided by nations participating in the AG.

I.1 UK EXAMPLES

Technical white paper for NATO Urban Combat Advanced Training Technologies Task Group

Matt Wright, QinetiQ, United Kingdom.

I.1.1 Better Training, Bigger Audience, Cheaper

The Live training domain is defined by SISO as:

> *The domain where live participants operate operational systems and platforms (including their full range of mobility) in the physical environment.*

By integrating synthetic environments (as represented by the Virtual and Constructive domains) into the Live domain, benefits are gained in terms of increased realism, broader training audience participation and cost savings over fully live training.

I.1.2 Context

To enable bi-directional live-virtual-constructive (LVC) integration, information from the Live domain needs to be captured and represented in Synthetic Environments. Live domain information is currently captured using GPS, laser engagement and other instrumentation technologies.

Such instrumentation is becoming ubiquitous in live training as the technology price drops and the capability increases. Advances driven by the frantic development cycle of modern consumer electronics are providing benefits in:

- Fast, efficient mobile computer platforms;
- High-capacity and infrastructure-less wireless data networks; and
- High power density batteries.

The decrease in Western defence budgets has impacted traditional live training activities. Live firing smart munitions and operating complex modern vehicles comes with a price tag that rapidly makes live-only training unaffordable. There is a push to implement synthetic domain solutions in the live to reduce costs whilst maintaining training effectiveness.

As the need for LVC integration grows, so will the proliferation of LVC architectures and middle-ware solutions. The availability and variety of LVC integration solutions will reduce the entry costs traditionally associated with synthetic-enhanced live training. This will make 'plug-and-play' LVC exercises a realistic proposition for many Armed Forces.

The following sections describe some of the current uses for LVC integration and an exploration of potential future uses.

I.1.3 Current Uses

I.1.3.1 Synthetic Wrap-Around

Synthetic wrap-around has been used to enhance the ‘deep battle’ with constructive entities. Management of the live/synthetic boundary is achieved by geographically isolating the live domain from the synthetic (see Figure I-1).

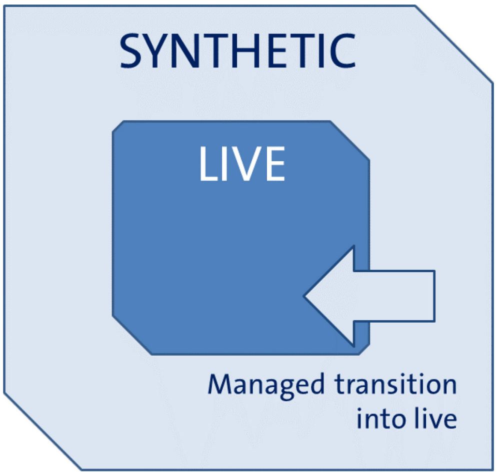

Figure I-1: Synthetic Wrap-Around.

The synthetic deep battle is visualised on virtual simulators (e.g., Ground Moving Target Indication radar, tactical UAVs, ISTAR sensors). As synthetic entities move into the live domain they are ‘replaced’ by a live instrumented version of the entity at the live/synthetic boundary.

I.1.3.2 Synthetic ISTAR

Synthetic UAV and ISTAR are used in training where real systems are expensive or not authorised to operate in civilian airspace.

Figure I-2: Synthetic UAV.

I.1.3.3 Synthetic Fall of Shot

Synthetic fall of shot enables indirect fires to be visualised in the live domain. It is common practice to provide the soldier with audio feedback on indirect fire events; providing an indication of direction and range to the effect. This is not accurate enough for forward observers to call for corrected fires. By overlaying the synthetic environment effect on a real-world view, e.g. by injecting synthetic imagery into binoculars, the forward observer can judge the correction needed for the next salvo. This can be considered as a form of Augmented Reality. Figure I-3 shows a fall of shot synthetic indicator, a through-sight Augmented Reality system used by the British Army.

Figure I-3 : Fall of Shot Synthetic Indicator.

I.1.3.4 Air/Land Integration

Virtual air simulators can be used to deliver cost effective air/land integration training alongside instrumented live training. Both land and air training audiences participate in a synchronised live/synthetic environment. Live instrumented entities are recreated in the virtual world enabling pilots to see and engage targets on the ground. By incorporating Augmented Reality (see synthetic fall of shot), land trainees can visualise effects from the synthetic environment.

Figure I-4: Virtual Fast Jet Cockpit.

I.1.3.5 Unmanned Sensor Stimulus

Unmanned and autonomous sensors can be emulated in live training without the need to deploy and maintain operational sensor systems. The sensors can be modelled in a synthetic environment and stimulated by information from training instrumentation. Feedback, alerts and warnings generated by the synthetic model are fed into the live training audience. Such operational systems could include motion detection sensors, infra-red tripwire sensors and shot detection sensors.

I.1.4 Future Uses

I.1.4.1 Armour/Infantry Integration

To reduce track mileage costs in driving armoured vehicles, it is conceivable that future live infantry exercises will be supported by virtual AFVs (Armoured Infantry vehicle or main battle tank). The vehicle crew would see a virtual representation of the ground and be able to engage targets for the infantry. This would be of particular use where armour is providing depth fires, say in an urban break-in battle or other close-quarter infantry engagement where the physical presence of the vehicle is not needed as part of battle inoculation.

Figure I-5: Virtual AFVs.

I.1.4.2 Organic Land Air Defence

As airborne systems become cheaper to employ, such as micro UAVs, missiles and helicopters, the need for land forces to defend themselves from air attacks will increase. To enable training in reaction to air threats, virtual simulations can be used to stimulate live troops on the ground. Augmented reality would then be needed to enable troops to acquire, target and engage virtual air threats.

I.1.4.3 Embedded Training Modes

Infantry and vehicle sensors and targeting systems are becoming increasingly sophisticated. Research into 'hard kill' defensive systems will eventually become standard fit to armoured vehicles. Several nations are trialling wearable shot detection systems that can provide range and direction to enemy firing points. At some point in time, the use of applique training systems will need to transition to embedded training systems. This transition will present an opportunity to inject augmented reality threats into sighting systems and to stimulate operational sensors with entities from synthetic environments.

I.1.4.4 Synthetic Targetry for Live and Simulated Firing

Current target technology uses acoustic methods to detect the path of a round through a target. The target itself only provides something for the shooter to aim at. By removing the physical target and replacing it with either a projected virtual or augmented reality target, live firing in the future could be made more dynamic and realistic than can be achieved with target lifters and pop-ups.

I.2 NLD EXAMPLE

Urban Short Range Interaction (USRI): an LVC solution to Urban Operation Training

Muller, Krijnen, Visschedijk (2012), I/ITSEC 2012.

USRI is one of several cases and projects under the umbrella of the TNO's (the Netherlands Organisation for Applied Scientific Research) LVC programme. The LVC programme is commissioned by the Royal Netherlands Armed Forces and focuses on enriching one simulation domain (live, virtual or constructive) with another. The programme contains several cases, each with a different angle and focus. The USRI case focuses on enhancing the live environment with virtual entities.

I.2.1 The Concept

The goal of USRI is to present a trainee of in a built up area with a virtual role player with whom he can interact in a meaningful and non-intrusive way in a live training environment. This means that the trainee is aware of the virtual role player, but also the other way around: the virtual role player needs to know what the trainee is doing in order to react appropriately. The purpose of a system based on the USRI concept would be to present users with more challenging and lifelike targets. Operators can more easily train action-intelligence and shoot/no-shoot decision making, but also be confronted with role players that are otherwise hard to present like elderly people, animals and children.

I.2.2 Proof of Concept

In 2012 a demonstrator was built using COTS available components. For presenting the virtual role player to the trainee, a standard beamer was used. For position and skeletal tracking of the trainee a Microsoft Kinect depth-sensing camera was used together with its free Software Development Kit to enhance interaction between the virtual and the live entity, automated speech recognition (ASR) was incorporated into the system, for which Loquendo was used. ASR so far is limited to short standard commands like "get down" or "show your hands". For weapon tracking a blue gun was instrumented with a wireless micro switch (trigger) and orientation sensor. Finally, VBS2 with a custom written plug-in posed the "brain" of the setup, translating sensor data into avatar behaviour. During a workshop, organised to obtain user requirements, the demonstrator was introduced to several army, marine and (military) police field operators.

Figure I-6 shows the USRI demonstrator setup, with the beamer in the white box, the Kinect camera front and centre and the soldier with an instrumented blue gun and headphone with microphone.

Figure I-6: The USRI Demonstrator Setup.

I.2.3 Future Development

The Royal Netherlands Army is currently investigating the possibility to follow up on the research done on the USRI concept. The plan is to use virtually presented role players in the newly built shooting houses. The use of virtual role players is even more advantageous in a live fire environment where live role players cannot be used at all.

Figure I-7: The Virtual Role Player Reacts Differently on the User's Actions.

I.2.4 Relation to UCATT

If systems like USRI were to be used in an integrated fashion with live training, the virtually presented role players could be considered as players and given a player ID. Consequently, the need for data logging and monitoring would exist as it does for live entities. EXCON could also control these virtual entities like they would with other targetry. During the project, even the use of the laser based Small Arms Transmitter for hit-point detection was already examined, be it only on the surface.

Annex J – QUICK SCAN OF APP-6(C) NATO JOINT MILITARY SYMBOLOGY

The military subgroup within the AG has made a quick scan of the APP-6(C) (MAY 2011 edition) to find out if there is symbology missing for visual presentation in EXCON, or MOUT training in general. As a starting point the subgroup decided to look at the lowest level where MOUT operations are conducted. This Annex provides the preliminary results, in terms of missing symbols or modifiers.

Weapons (Or Weapon Systems)

- Shotgun.
- Sniper Rifle (there is a symbol for Single Shot Rifle, but that says nothing about the effective range of that rifle).
- Pistol.
- Anti-structure rocket launchers (e.g., PzF-3 Bunkerfaust or SMAW II).
- Hand grenade.
- IED types. There is a symbol for IEDs, however, there is no symbol to indicate the type of IED, e.g., Remotely Controlled (Radio, Command Wire, etc.) or Victim Operated (Pressure Plate, Trip Wire, etc.).
- Pepper spray.

Entities (Either Civilian or Military)

- Prisoner (not a POW, but a civilian prisoner taken under civilian law, by military personnel).

Structures

- Nuclear power plant.
- Most civilian structures or objects (e.g., train station, hospital, public transport).

Non-Play Entities

- O/C.
- Fire marker.
- EXCON.

Control Measure Symbols

- Secure object, enemy oriented or object oriented, with the addition of HVT (High Value Target), MVT or LVT.
- Floor modifier (added to any symbol to declare the specific floor in a building on which that entity or unit resides or that event or action takes places).

Annex K – UCATT's RULES OF BUSINESS

RULES OF BUSINESS

(Original Version 1.0 dated 16 August 2012)

(Revision 1.2 dated 19 September 2012)

(Revision 1.3 dated 26 November 2012)

INTERNATIONAL MODEL NORTH ATLANTIC TREATY ORGANIZATION

Adopted for UCATT

PART I: MEETINGS

Meetings of UCATT (Architecture and Standards) will be held at a time and place designated by the Steering Group.

PART II: AGENDA

1) The agenda for regular meetings of UCATT shall be drawn up by the Steering Group and communicated to the members at least two weeks prior to the opening of the meetings.

2) The first item of business for each meeting shall be the approval of the working agenda by a simple majority vote of the members present.

3) Additional items may be placed on the agenda, if the UCATT group so decide by a simple majority vote of the members present.

PART III: REPRESENTATION

1) Each active member shall be allowed one vote. For voting purposes, members become inactive when they fail to attend two consecutive meetings.

2) Representation at each meeting will be certified by the Group Chairperson and/or Group Secretary.

3) Members are requested to participate to all the meetings, when for reasons participation is not possible they should tell (in writing) this ASAP to the Group Chairperson and Group Secretary.

PART V: THE CHAIRPERSON

1) The Group Chairperson shall have the responsibility of ensuring the smooth operation of the meeting through interpretation and enforcement of the Rules. In addition to exercising powers described elsewhere in the Rules, the Chairperson shall declare the opening and closing of each meeting, direct discussions, accord the right to speak and announce decisions. He/she shall rule on points of order and, subject to these Rules, shall have complete control of the proceedings at any meeting. The Chairperson may suspend the rules for the conduct of business when appropriate and for the convenience of the group. All votes on decisions within the group must be managed in accordance with the voting rules which may not be suspended by the Chairperson.

2) The decision of the Chairperson may be appealed by any member. This motion is debatable by one member in favour and one against, after which the motion shall be put to a vote. The Chairperson's decision will stand unless overruled by a two-thirds majority of eligible voting members present.

PART VI: CONDUCT OF BUSINESS

Business processes for UCATT:

1) The Group Chairperson may declare the meeting open if one-third of the members are present. The presence of a majority of voting eligible members is required for a decision to be taken (other than agenda modifications).

2) The Group Secretary will produce a list of all members that are present at the meeting.

3) Committees are sub-elements of the overall Group and will not apply these rules to their activities other than their responsibility to generate draft language and decision proposals.

4) Voting on draft language and decision proposals shall only occur at the Group Level within UCATT.

5) Decision motions (other than agenda modifications) must be developed by the Committees and submitted in writing to the Group Chairperson and Secretary. The Chairperson may take up to twelve (12) hours to review the motion before presenting it to the overall membership for review.

6) Decision motions must be presented to the voting members at least 12 hours before the vote is called to allow review and consultations.

7) Amendments may be proposed by any member during discussion and must be presented to the Group Chairman in writing or through dictation (word for word) during live discussion.

8) The following motions shall be utilised to facilitate decision making during the meeting:

   a) Decision Proposal (Motion)

      To introduce a new piece of business or propose a new decision or action, a motion must be made by the Committee Chair/Secretary ("I move that......"). A second motion must then also be made (raise your hand and say, "I second it.") After debate & discussion the group then votes on the motion. Administrative motions regarding business proceedings or deliberations regarding a pending decision or action may be made by any active member. A second motion may be required as appropriate along with additional discussion. All administrative motions must be resolved prior to voting on affected decision or action motions.

      Note*:* If more than one motion is proposed, the most recent takes precedence over the ones preceding it.

   b) Point of Order

      During the discussion of any matter, a member may raise a Point of Order, and the point of order shall be immediately decided by the Chairperson in accordance with the Rules of Procedure. A Point of Order may relate to the maintenance of order, the observance of Rules, or the way in which the presiding officers exercise the powers conferred upon them. An argument for or against the pending question shall not be recognised as a valid point of order. ***A point of order is the only circumstance under which a speaker may be interrupted***. The Chairperson may refuse to recognise points of order if it is their judgment that the member has not maintained the restraint and decorum which should govern the use of such a right, or if in their judgment the point is clearly dilatory in nature.

c) Point of Information

A Point of Information is raised to the Chairperson if a member wishes to obtain a clarification of procedure or a statement of the matters before the body. Members may not interrupt a speaker on a Point of Information.

d) Point of Inquiry

A member requesting clarification or additional information will raise a Point of Inquiry. A Point of Inquiry may be used to question a speaker only after he/she has finished their remarks and may not interrupt any speaker. A questioner will address the Point of Inquiry to the Chairperson, who will then ask the speaker if they *wish to yield*.

e) To Suspend the Meeting

During the discussion of a matter, a member may move for the Suspension of the meeting. Should the Chairperson entertain it, it shall immediately be put to a vote. The suspension of a meeting requires a simple majority of the members present and voting.

f) To Adjourn the Meeting

At the conclusion of business defined in the approved agenda, a member may move for the Adjournment of the meeting until the next scheduled date. This motion is only in order for the full membership and requires a second and a two-thirds majority.

g) To Suspend Debate on the Item under Discussion

During the discussion of any matter, a member may move to Suspend debate on the item under discussion. Two representatives may speak in favor of the motion and two against the motion, after which the motion shall immediately be put to a vote. This motion requires a two-thirds majority to pass.

h) To Close Debate on the Item under Discussion

A member may move for Closure of debate on the item under discussion; whether or not any other member has signified his/her desire to speak. Two members may speak in favor of the motion and two against, after which time the motion shall be put to an immediate vote. This motion requires a two-thirds majority vote to pass.

i) To Postpone Indefinitely

This tactic is used to kill a motion. When passed, the motion cannot be reintroduced at that meeting. It may be brought up again at a later date. This is made as a motion ("I move to postpone indefinitely..."). A second is required. A majority vote is required to postpone the motion under consideration.

j) To Change the Order of Consideration of Agenda Items

Agenda items will be considered in the order in which they appear on the agenda, unless that order is altered by the passage of a motion To Change the Order of Consideration of Agenda Items. This motion is only in order during the first session of the conference. Once the agenda has been set, it may not be changed unless the group is tasked with a crisis by the Steering Committee. A majority vote is needed for passage.

k) To Limit Debate on the Item under Discussion

When discussing an item on the agenda, a member may move to Limit Debate. The purpose of this motion is to focus the committee's attention on the topic or individual draft resolution or amendment. Once this motion has passed, debate is limited to introducing and discussing any draft language under that topic. A member may also limit debate to draft language or an amendment, meaning all discussion must be relevant to the document at hand. Once limited,

debate on a topic or document can be suspended or closed. This motion requires a second and a simple majority.

l) To Divide the Question

In the group, a member may move to Divide the Question, so that parts of draft language or an amendment could be voted on separately. If objection is made to the request for division, the motion shall be voted upon, requiring a simple majority to pass. Permission to speak on the motion shall be accorded to two speakers in favour and two against. If the motion for division is carried, those parts of the proposal shall then be put to a vote as a whole. If all operative parts of the proposal or of the amendment have been rejected, the proposal or the amendment shall be considered to have been rejected as a whole.

m) To Amend the Item under Discussion

An Amendment is that which adds to, deletes, or alters part of the Draft Language. Amendments must be submitted in writing (or dictated word for word during live forum) to the Chairperson during the discussion of a Draft Language and must receive their approval. The Chairperson may, at their discretion, limit the number of amendments or request members to combine similar amendments. Amendments shall be numbered in the order in which they are received. Once the Amendment is introduced, all sponsors of the draft language to which the Amendment pertains must be asked if the Amendment is Friendly or Unfriendly. If the Amendment is deemed Friendly by all Sponsors, then it is automatically adopted into the Draft Language. If the Amendment is deemed Unfriendly by any of the Sponsors, then it is dismissed and voted upon by the Group. The Group may limit debate to any dismissed Amendment and at the closure of debate on the Amendment, the Amendment will be voted upon by the Group. Regardless of limitation, *all* dismissed Amendments must be voted upon by the Group after the closure of debate on relevant draft language.

This is the process used to change a motion under consideration. Perhaps you like the idea proposed but not exactly as offered. Raise your hand and make the following motion: "I move to amend the motion on the floor." This also requires a second. After the motion to amend is seconded, a majority vote is needed to decide whether the amendment is accepted. Then a vote is taken on the amended motion. In some organisations, a "friendly amendment" is made. If the person who made the original motion agrees with the suggested changes, the amended motion may be voted on without a separate vote to approve the amendment.

n) To Reconsider

When a proposal has been adopted or rejected it may not be considered at the same session but may be introduced at the next meeting and must be approved by a two-thirds majority. Permission to speak on a Motion to Reconsider will be accorded to speakers opposing and favouring the motion.

o) Right of Reply

The Chairperson may accord a Right of Reply in the case of grave personal insult and injury. The offence to which the member is responding must occur within formal debate. The right of reply must be submitted in writing to the Chairperson. Upon the Chairperson's approval, the member may move for a right of reply. The time granted for a right of reply is at the Chairperson's discretion. There may not be a right of reply in response to another member's right of reply.

p) Call the Question

To end a debate immediately, any member, when mandatory debate has been completed regarding a specific draft language or decision proposal, may Call the Question which when

seconded serves to direct the Chairperson to discontinue discussion and poll the voting membership for a vote on the issue at hand. A two-thirds vote is required for passage. If it is passed, the motion on the floor is voted on immediately.

q) Commit

This is used to place a motion in committee. It requires a second. A majority vote must rule to carry it. At the next meeting the committee is required to prepare a report on the motion committed. If an appropriate committee exists, the motion goes to that committee. If not, a new committee is established.

r) Table

To Table a discussion is to lay aside the business at hand in such a manner that it will be considered later in the meeting or at another time ("I make a motion to table this discussion until the next meeting. In the meantime, we will get more information so we can better discuss the issue.") A second is needed and a majority vote required to table the item being discussed.

PART VII: VOTING

1) Each active member within UCATT shall be accorded one vote in the Group.

2) Voting must be either in person or by proxy. If by proxy, the voting member must designate to the Chairperson and Secretary their proxy from the list of existing eligible UCATT voting members. The proxy vote may be cast only on decision motions formally announced in a previous UCATT meeting.

3) All decision proposals of the Group must be approved by a simple majority of all voting members present, but with the realisation that unanimous consent is desirable.

4) Administrative motions shall be voted on in accordance with the relevant parts of the Rules.

5) Immediately prior to a vote, the Chairperson shall describe to the body the item to be voted on, and shall explain the consequences of a "yes" or a "no" vote. Voting shall begin upon the Chairperson's declaration "**the question has been called**," and end when the results of the vote are announced. Once in voting procedure, no member shall interrupt the voting except on a point of order concerning the actual conduct of the vote. Following Closure of Debate, and prior to entering voting procedure, the Chairperson shall pause briefly to allow members the opportunity to make any relevant motions.

6) Voting shall normally be carried out by raising of hands, unless a representative requests a **Roll Call Vote** where individual voters are called by name and respond with "Aye" or "No" verbally.

7) If hands are not raised indicating a **No** vote, then the Group Secretary shall record the vote as unanimous in the affirmative.

8) The term No with rights may be used by members wishing to explain their vote after voting has concluded. This right may be limited by the Chairperson.

9) A member may record a formal Reservation if a particular part of a proposal is partially unacceptable to him/her. This reservation is raised at the time of voting and will be formally recorded on the proposal in question.

PART VIII: GENERAL

1) The official language of the sessions is English.

2) Members are expected to dress in UCATT casual for the duration of the meetings.

3) The NATO UCATT Task Group Chair with the lower assigned MSG # will act as the overall Group Chairperson when multiple Task Groups are collaborating on the UCATT program.

4) The UCATT Group will consist of any and all NATO level Task Groups chartered to address the interoperability of instrumentation and operating with the UCATT name.

Voted on and unanimously approved by the UCATT membership in attendance – 19 September 2012.

Armin Thinnes
Chairman
NATO UCATT MSG-098

Annex L – TASK GROUP INFORMATION

L.1 PARTICIPATING NATIONS

Individual Nations that participated (representatives came from Government and/or Industry) are:

- Austria AUT
- Canada CAN
- Finland FIN
- France FRA
- Germany DEU
- Netherlands NLD
- Spain ESP
- Sweden SWE
- Switzerland CHE
- Turkey TUR
- United Kingdom GBR
- United States of America USA

L.2 STEERING GROUP MEMBERS

Chairman: Mr. Armin Thinnes, German Federal Office of Bundeswehr Equipment, Information Technology and In-Service Support, GOV, DEU.

Secretary: Mr. Osmo Forsten, Finnish Defence University, GOV, FIN; ad interim: Mr. Jan Vermeulen, Defence Materiel Organisation, GOV, NLD.

Other Steering Group Members: Mr. Gary Washam, CUBIC, IND, USA; Maj. Johnny Gullstrand, GOV, SWE; Mr. Rudi Gouweleeuw, GOV, NLD.

L.3 PARTICIPANTS

Participants of MSG-098 and MSG-099 are listed in the table below.

Table L-1: UCATT-3 MSG-098 and MSG-099 Participants.

Nation	Rank/Title	Name	Department/Company	Timeframe*	MSG
SWE	Mr.	Alexanderson, Magnus	SAAB AB	2012 – 2015 (8)	99
USA	Mr.	Blahnik, Steve	Cubic Global Defense	2012 – 2015 (8)	99
USA	Mr.	Campos, Jesse	PEOSTRI	2011 – 2015 (9)	98
GBR	Mr.	Chamberlain, Mark	Defence Equipment and Support UK MoD	2011 – 2015 (11)	98

Nation	Rank/Title	Name	Department/Company	Timeframe*	MSG
DEU	Mr.	Christians, Ernst	Rheinmetall Defence Electronics GmbH	2014 – 2015 (2)	98
TUR	Mr.	Colakoglu, Cagatayhan	Aselsan Inc.	2011 (1)	98
FRA	Mr.	Coriat, Michel	Thales Training & Simulation	2011 – 2014 (7)	98
NLD	Capt	Cruiming, Sander	Royal Netherlands Army	2011 – 2015 (12)	98
USA	Mr.	Dasher, Mark	PEOSTRI	2011 (1)	98
FRA	Mr.	Desfachelles, Thomas	Direction Générale de l'Armement	2011 – 2014 (7)	98
FRA	Mr.	Desruelles, Philippe	Airbus Defence & Space	2011 – 2014 (5)	98
DEU	Dr.	Dobrindt, Uwe	Rheinmetall Defence Electronics GmbH	2014 – 2015 (3)	99
DEU	Mr.	Eisenhauer, Joachim	Rheinmetall Defence Electronics GmbH	2011 – 2015 (8)	99
CHE	Ret Col	Fenner, Max	RUAG Defence	2012 – 2015 (10)	98
CAN	Mr.	Forgues, Stéphane	Department of National Defense	2013 (2)	98
FIN	Mr.	Forsten, Osmo	Finnish Defence Forces	2011 (2)	98
NLD	Mr.	Gouweleeuw, Rudi	Netherlands Organisation for Applied Scientific Research TNO	2011 – 2015 (12)	98
SWE	Maj	Gullstrand, Johnny	Swedish Armed Forces	2011 – 2015 (12)	98
AUT	Lt Col	Habitzl, Wolfgang	Austrian Armed Forces	2015 (1)	98
NZL	Mr.	Handley, Paul	Cubic Global Defense	2012 – 2013 (3)	99
SWE	Mr.	Holmquist, Anders	SAAB AB	2011 (1)	99
AUT	Lt Col	Horak, Robert	Austrian Armed Forces	2014 (2)	98
SWE	Maj	Karlsson, Roger	Swedish Armed Forces	2012 – 2013 (4)	98
CHE	Lt Col	Lerch, Rolf	Swiss Armed Forces	2011 – 2012 (4)	98
SWE	Mr.	Lindstrom, Anders	SAAB AB	2011 – 2014 (10)	99
DEU	Lt Col	Makowski, Peter	German Armed Forces	2011 – 2015 (10)	98
SWE	Mr.	Martinsen, Staffan	Swedish Defence Materiel Administration /FMV	2013 – 2015 (5)	98
DEU	Mr.	Neugebauer, Holger	WTD91, German Armed Forces	2014 – 2015 (3)	99
SWE	Mr.	Nyfelt, Leif	NSC	2011 (1)	99

Nation	Rank/Title	Name	Department/Company	Timeframe*	MSG
ESP	Maj	Pinedo, Carlos Belinchón	Spanish Armed Forces	2011 (2)	98
USA	Mr.	Platt, Kyle	PEOSTRI	2012 (1)	99
DEU	Mrs.	Ross, Bettina	Drew Defense (formerly Chemring Deutschland)	2012 (2)	99
DEU	Mr.	Thinnes, Armin	German Federal Office of Bundeswehr Equipment, Information Technology and In-Service Support	2011 – 2015 (12)	98/99
USA	Mr.	Tucker, Frank	PEOSTRI	2012 (1)	98
NLD	Mr.	Vermeulen, Jan	Defence Materiel Organisation	2011 – 2015 (11)	98/99
FRA	Mr.	Vinatier, Thierry	Airbus Group GDI Simulation	2011 – 2015 (11)	99
SWE	Mr.	von Rothstein, Niclas	Swedish Defence Materiel Administration /FMV	2011 (1)	98
USA	Mr.	Washam, Gary	CUBIC Global Defense	2011 – 2014 (7)	99
DEU	Mr.	Wittwer, Ingo	RUAG Defence Deutschland GmbH	2011 – 2015 (12)	99
GBR	Mr.	Wright, Matthew	QinetiQ Plc	2012 (1)	98
TUR	Mr.	Zafer, Yahsi	Aselsan Inc.	2011 (1)	98
FRA	Ms.	Zundel, Catherine	Direction Générale de l’Armement	2015 (1)	98

* Number of Meetings attended shown in brackets

L.4 MEETING LOCATIONS

Table L-2: UCATT MSG-098 Meeting Locations.

2011	2012	2013	2014	2015
	Warminster (GBR)	Rome (ITA)	San Diego (USA)	Vienna (AUT)
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14. Abstract

The Urban Combat Advanced Training Technology (UCATT) Architecture Task Group (TG) was established within the NATO Modelling and Simulation Group (NMSG) in 2011 as MSG-098 TG. Simultaneously UCATT Standards TG was established as MSG-099. Together they form the UCATT TG. The UCATT Architecture TG was tasked to continue to exchange and assess information on Military Operations in Urban Terrain (MOUT) or Urban Operation facilities and training/simulation systems with a view toward establishing best practice. It was also tasked to maintain and enhance the UCATT functional architecture developed during MSG-032 UCATT-1 that proved its feasibility during a technical demonstration within the activities of MSG-063 UCATT-2. Another important task was the prioritisation of interfaces to be standardised through the MSG-099 UCATT Standards TG and the definition of Datasets traveling through these interfaces as important input for the standards group. The group evaluated the applicability of existing standards as potential candidates for the realisation of UCATT interfaces (e.g. MSDL, C-BML, JC3IEDM). The SISO standardisation activities of the UCATT Standards TG are supported by all members of the UCATT Architecture TG who form together the SISO UCATT PDG.

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